SHORT-TERM VEGETATION RESPONSE TO PRESCRIBED BURNING IN THE SAGEBRUSH/GRASS ECOSYSTEMS OF THE NORTHERN GREAT BASIN; THREE YEARS OF POSTBURN DATA FORM THE DEMONSTRATION OF PRESCRIBED BURNING ON SELECTED BUREAU OF LAND M MANAGEMENT DISTRICTS

FINAL REPORT FIR COOPERATIVE AGREEMENT
No. 22-C-4-INT-033
WITH SYSTEMS FOR ENVIRONMENTAL MANAGEMENT
Co-op Contact: Charles L. Bushey
FS Contact: J.K. Brown

In TWO PARTS

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Final Report for Cooperative Agreement
#22-C4-INT-033
with Systems for Environmental Managemen
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Short-Term Vegetation Response to Prescribed Burning in the Sagebrush/Grass Ecosystem of the northern Great Basin; three years of postburn data from the Demonstration of Prescribed Burning on Selected Bureau of Land Management Districts.

Charles L. Bushey

Systems for Environmental Management

A final report submitted to partially fulfill the requirements of Cooperative Agreement 22-C-4-INT-33.

June 15, 1987

SYSTEMS FOR ENVIRONMENTAL MANAGEMENT

P.O. BOX 8868
MISSOULA, MONTANA 59807
PHONE: (406) 549-7478

SYSTEMS FOR ENVIRONMENTAL MANAGEMENT

A Natural Resources Research Group

Systems for Environmental Management (SEM) is a non-profit research and educational corporation based in Missoula, Montana, a regional center for natural resources agencies. Founded in 1977, SEM works cooperatively and under contract with the U.S. Forest Service, National Park Service, Bureau of Land Management, and Bureau of Indian Affairs, as well as state and academic institutions, private individuals and organizations.

SEM's diverse professional staff offers a wide range of research capabilities within the natural resources management field. The full-time staff includes specialists in fire behavior, fire history, recreation management, geography, plant ecology, forestry, meteorology, data analysis, and computer science. SEM also maintains a pool of professional affiliates that can be utilized for projects requiring additional expertise. Areas of recent research emphasis include wilderness recreation management, fire history and ecology, fire planning, and development of computerized resource management tools.

→ C. Elword

INT - IFSL

United States Department of Agriculture

Forest Service

Reply to: 4040 Cooperatives

Date: November 13, 1987

Subject: Final Report - 22-C-4-INT-033

To: Director, INT
THRU: Richard G. Krebill, ASD-Research ~~B&RA~~ ~~BRA~~ WESTFORNET IN Turn

RK

Enclosed are two reports dealing with (1) three-year post burn response in the sagebrush/grass ecosystem and (2) methods for monitoring and evaluating prescribed fires. These are the final reports for the Cooperative Agreement with Systems for Environmental Management involving a prescribed fire demonstration study on BLM lands in four western states (22-C-4-INT-33). All obligations of this Coop Agreement have been met and it should be officially terminated.

James K. Brown

JAMES K. BROWN
Project Leader
RWU 4403

Enclosure

See also:

METHODS FOR MONITORING AND EVALUATION =
BUREAU OF LAND MANAGEMENT RESOURCE OBJECTIVES.

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I. Report Introduction and Monitoring Issues of Concern.

The primary objective of this report is to present fire effects results with data collected from several USDI Bureau of Land Management districts in the sagebrush/grass ecosystem of the northern Great Basin. Data from baseline vegetation samples and three years of postburn results are evaluated for the short-term fire effects on individual species components of the plant communities studied and the ecosystem in general. Four districts from four western USA states, and six prescribed fires were involved in the project. Only the results from four fires from three districts are presented due to insufficient information collected from two fires on one of the districts involved.

Each BLM district approached the monitoring of their prescribed fire projects in slightly differing manners. Yet, their desired end products were to be utilized in similar manners. The district Range Conservationists wanted a chronicle of change in the vegetation that could be attributed to the prescribed fire treatment (fire effects). This information would then be used to adjust the allotment management if necessary. Four important points were considered necessary before this end result could be accomplished by monitoring the prescribed fire treatments;

1) To document any vegetation changes it is necessary to have prior measurements (baseline data) before a treatment is initiated for comparative purposes,
2) If specific resource (management) objectives have been identified it is important that the necessary monitoring be directed at providing pertinent data that can be utilized in evaluating accomplishment of those objectives,
3) Control transects placed near the treatment transects in similar vegetation and terrain are necessary to separate the treatment effects from other influences.
4) Treatment transects not only had to be placed in representative, sites which show a homogeneity of vegetation composition; but also had to be placed on areas with a high probability of receiving the treatment.

In most cases the districts used monitoring techniques that they had previous experience with from their on-going range trend studies. (These techniques differed on each district and are presented in earlier documentation.) These monitoring techniques did not always provide the necessary data to evaluate stated resource and fire objectives and several districts supplemented their standard methodology with additional studies. Most districts also saw an opportunity because of this project to initiate transects in areas where they wanted long-term range trend information. To establish a baseline data set these new transects were read at least one growing season prior to the treatment.

Monitoring Issues

During this project several issues concerning monitoring, and in particular monitoring on prescribed fires, have been raised by BLM personnel. These issues were developed into four separate questions at

a recent BLM "Prescribed Fire for Resource Management" workshop (Salt Lake, UT., March 3 - 5, 1987). Prior to the vegetation monitoring results of this report I think it appropriate to address these questions and in brief provide some insight into the concerns. There are no clear-cut answers to these questions, and the opinions expressed are those of the author and should not be construed as policy for any agency.

Question 1. What fire and resource parameters or factors need to be monitored?

This question really addresses two very separate and different areas of monitoring, resources parameters and fire parameters. Resource parameters are items whose change can be measured over long periods of time, and whose data are collected at specified time intervals. These parameters directly relate to the type of long-term land management a unit of landscape receives. The parameters that need to be measured will be determined by the resource objectives which establish the long-term goals of land management that are to be either attained or maintained. It is the responsibility of the Resource Manager to establish the resource objectives and monitor the resource parameters. The most commonly measured primary resource item is vegetation composition. Various other improvements in primary resource parameters such as herbaceous productivity, above ground biomass, plant diversity, the preservation or restructuring of vegetation patterns, and prevention of erosion are also frequently mentioned. Secondary resource objectives pertain to changing or maintaining desired levels of life forms dependent upon the vegetation being managed. These secondary objectives will relate to livestock or wildlife management, and may be as diverse as including changes in insect activity.

When resource parameters are not a part of a standardized data collection methodology they will require additional monitoring techniques or modification of the data collection to incorporate the needed change. Correspondingly, there is no reason to collect data not necessary to evaluate the resource objectives. The Resource Manager has the responsibility to closely review their resource objectives and develop efficient monitoring programs that will satisfy the data collection needs. Do not sacrifice resource objectives simply because you do not like to conduct monitoring, monitoring is an integral portion of the land management program.

Fire parameters, when compared to resource parameters, tend to be very short-term items with data collected only once or twice. They are measurements whose responsibility to collect and interpret belongs to the Prescribed Fire Manager, or delegated to an individual on the fire staff. These fire parameter measurements are used to determine if fire objectives as specified in the Prescribed Burn Plan were meet. Again, the fire objectives must be clearly defined and unnecessary objectives deleted. Fire objectives usually list acceptable limits to the first level achievable goals of the fire. These usually include the fire parameters of fuel consumption, smoke production, and immediate mortality; parameters which evaluate the success of the prescribed fire. Other fire parameters commonly identified in Burn Plans include fire behavior limitations, measurements of soil and fuel moisture, and

weather parameters. These fire parameters contribute information which aids the Prescribed Fire Manager in following their fire prescription and obtaining the fire objectives.

Fuel consumption measurements are one of the few fire parameters that needs to be measured on different occasions, pre- and posttreatment. Without a preburn fuel load inventory it will be impossible to later determine consumption. A preburn evaluation of fuel bed continuity at the same time fuel loading is determined will also help enable the Prescribed Fire Manager to determine if the fire objectives can be meet during the pretreatment planning stages. If the Prescribed Fire Manager believes that either the site will not burn sufficiently to obtain fire objectives or because of high fuel loads safety and cost are factors to question the treatment, then a different management technique may need to be considered.

Preburn fuel loadings are also necessary to determine the potential amount of smoke the prescribed fire treatment will produce. This information is necessary to help the Prescribed Fire Manager predetermine potential smoke impacts on sensitive receptor sites such as highways or residential communities, or to realize if air quality regulations may be violated. With the proper preburn data the Prescribe Fire Manager may be able to adjust his fire prescription to satisfy safety and legal concerns and still assure a proper site treatment. Monitoring of the smoke plume during the fire may also be necessary and observed parameters would include column lift and direction of movement, smoke duration and dispersion on-site or at sensitive receptor sites.

Immediate postburn mortality usually pertains to vegetation but also may relate to wildlife, insects or even specific diseased populations. This evaluation, depending on its importance, may be either quantitative or qualitative and will need a preburn evaluation of the population to be treated. Frequently the preburn evaluation can be part of the resource parameters measured either before or during the planning phase of the project. The evaluation of postburn mortality in some cases will be quite easy to accomplish, in other cases it will engage the fire effects knowledge and experience of the Prescribed Fire Manager. The mortality study must also be restricted to a life form that will illicit a known short-term response to the treatment such as sagebrush, juniper, or drawf mistle-toe infected Douglas-fir. Mortality of bunchgrasses would fall under the category of a resource parameter because of the postburn response time involve thought the Prescribed Fire Manager may be able to provide a qualitative evaluation based on this experience in the field.

Question 2. What are the appropriate monitoring methods / techniques?

The appropriate monitoring methodology will vary depending on two key factors; what parameter needs to be evaluated, and what level of information is needed to make the necessary management decisions. There are many excellent monitoring methods that can be implemented, more than I would have time or space to reference. In most cases there will not be a need to invent "new" techniques. The Resource Manager should be able to carefully evaluate and select the best combination of current methodology to accomplish the monitoring job. So I will only cover some

of the concepts of what needs to be considered in the methodology selection process.

When selecting a monitoring technique the manager needs to pick a method that will provide the proper data to evaluate the situation being studied. Future use of the data may also be an important consideration. If the district data will eventually be combined with state or regional data bases the information acquired must be compatible. Data compatibility will be one of the biggest problems the BLM will have in the future as the agency tends more toward electronic data management and addressing regional trends for planning purposes. Other factors that need to be considered when selecting a sampling technique are;

1) efficiency - the sampling methods need to be easily accomplished and understand, also they need to provide a maximum amount of information for the time and effort invested,
2) consistency - the data collection methods need to be capable of technique duplication by future individuals and crews,
3) appropriateness - the technique must be proper for the vegetation type and resource conditions being encountered,
4) sensitivity - determination of the level of precision, or accuracy necessary to detect changes over time,
5) analysis - the data acquired will need to be interpreted and evaluated in a meaningful manner that can be replicated and defended.

Question 3. What is the "right" level of monitoring intensity and what is the minimum level of monitoring necessary?

The answer to this question is really dependent upon the objectives needing to be monitored and what level of importance is placed on those objectives. All objectives need to be listed by priority. High priority objectives may demand very precise measurements at specified, repeated intervals. Objectives with lower priorities may be satisfactory evaluated with a one-time only, qualitative appraisal and recorded by close-up, or general view photographs. When the Resource Managers are selecting their monitoring techniques it will not only be necessary to use professional judgement on what may be technically adequate, but also in the political/social arena can be defensible if either objectives or management techniques are questioned. If the manager is not sure what technique would best fit the situation at hand, ask a qualified quantitative ecologist.

Usually when treatments such as prescribed fire, aerial spraying, or a revegetation project are finished the manager needs more information to evaluate the results than might be available from a range trend survey to adjust use of the allotment. They want to know if the treatment was successful and can't wait three to five years for an evaluation. This usually means more intensive sampling on a more frequent schedule than would normally be necessary on sites where nontreated range is receiving normal long-term evaluation. However, it also is not necessary to continue these more intensive studies beyond

when the ecosystem returns to a relatively stable condition as determined by your measurements. This duration needs to be flexible depending on the site and in case the treatment results are influenced by a negative impact from an unforeseen natural perturbation. Additional disturbance would place additional stress on the community and may demand additional changes in allotment management.

I might add at this point that proper documentation of the treatment results needs to be permanently filed. This may seem like an unnecessary topic to reenforce, unfortunately it is not, and lost data can severely hamper proper allotment management. Normally all forms, photographs and other pertinent data are filed in the allotment folder. There may even be an electronic backup file for some of the same information. Experience has shown that documentation does not always reach the proper folder, and with a turn-over in employees it becomes easy for necessary data to become misplaced. All retiring, or transferring personnel should be debriefed on projects for which they had responsibility. New personnel need to be brought up-to-date on what has taken place and their monitoring responsibilities.

Question 4. Does every burn need to be monitored? If not, what previous experience and documentation should there be to justify not monitoring?

The determination whether or not to monitor any land management treatment, prescribed fire or otherwise, is dependent on our ability to predict the effects of that treatment. The more complex the ecosystem being treated, the more complex will be the response with a corresponding decline in prediction success. Also the more complex the resource objectives being strived for the less likely prediction success will be attained. In a 1986 survey of experienced prescribed fire practitioners from across the nation, conducted by Systems for Environmental Management, Inc., the response was an overwhelming no. The survey indicated we are not sufficiently able to predict fire effects response based on observed fire behavior in the vegetation and fuel we are currently familiar burning in. Nationally 71% believed our fire effects knowledge was inadequate. Within the BLM subsample of the survey 81% felt they could not predict the fire effects. These numbers indicate to me that there is a need to continue monitoring prescribed fires, as well as other forms of treatment. It may not be necessary to monitor every prescribed fire. One fire may be sufficient if it is representative of several conducted during the same season, in the same general management vicinity and for similar resource objectives. But monitoring still needs to be a priority issue.

Comments from the survey show that the practitioners feel there is a need to learn more about the response within their own area. They had observed that frequently the responses were different than what had been reported in the literature from other sites. They believed these differences were due to local variations in weather and season, soil moisture, ecotypes and physiological status of the vegetation. When a fire staff on a district has acquired the experience, and has historically documented good response and objective attainment from allotments then the level of monitoring can be reduced.

Prescribed fire is not yet completely understood or accepted as a proper land management technique by all resource professionals.

Frequently the lack of acceptance stems from a minimum amount of education and experience concerning the implications of vegetation succession and knowledge on what can be, or can not be accomplished with prescribed fire. This type of resistance will gradually be overcome as the fire staff becomes more confident in what objectives they can realisticly attain and the other professionals have a chance to see the results. Though historically ancient, prescribed fire is still relatively new for government agencies as a management activity. The same survey referred to above, showed that nationally the maximum level of prescribed fire experience was 38 years with a median of only 12 years. Within the BLM the maximum experience level was indicated as 10 years and a median of 8 years. So in many respects we are still in the learning and training phases of prescribed burning, it is not a "Standard Operating Procedure". Until we can classify prescribed fire as "SOP" monitoring must continue and add to our knowledge base.

II. Laidlaw Park Burn Unit, Shoshone District, Idaho BLM.

Introduction

Only one transect in an *Artemisia tripartita*/*Agropyron spicatum* habitat type had been successfully treated with prescribed fire by the end of the 1986 growing season. Burn Transect 1 was successfully prescribed burned on September 15, 1983 under the following prescribed fire parameters;

Temperature - 70°F,
Relative Humidity - 14%,
Windspeed - 5 to 8 miles / hour,
Corrected Reference Fuel Moisture - 6 to 7%,
Live Sagebrush Moisture - 92%,
Soil Moisture - 4%.

Results and conclusions for this one treated transect and its control transect are presented. Baseline data on the biotic and abiotic site components were obtained on the treatment transect during the 1982 - 1983 growing seasons, and on the control during 1983. These data included information on changes in frequency, coverage, above ground biomass and the mortality/survival of specific plant species. Postburn data was collected in 1984 and 1986, the first and third postburn growing seasons.

Results

Bare Ground and Litter.

Coverage of bare ground showed no significant change during the baseline sampling periods (Table 1, Appendix 1). The amount of exposed bare ground increased significantly on the treated transect following the prescribe fire. The control transect during this time changed very little for this parameter. Coverage of the treated bare ground declined after the initial increase. Within three postburn growing seasons bare ground coverage on the treated transect was approximately equal to the preburn conditions.

Data has shown that when bare ground coverage increased there was a corresponding decrease in litter coverage, especially in nonpersistent litter (litter that decomposes at a relatively rapid rate, such as herbaceous plants). Persistent litter (litter that remains on-site for extended periods of time, such as manure or wood) results indicated large increases in the 1986 samples over previous sampling data levels on both the treatment and control transects. This apparent increase in persistent litter between the 1982 - 1984 sample period and the 1986 sample may be due to either a difference in interpretation of the litter classifications by the monitoring team, or a very substantial increase in coverage by manure and/or dead-down wood.

Table 1. Percent cover for the Laidlaw Park Burn Unit (1982-1986), Shoshone District, Idaho BLM. Prescribed fire treatment occurred on September 15, 1983.

	Burn Transect 1				Control Transect 1		
	1982	1983	1984	1986	1983	1984	1986
GROUND COVER							
Bare ground	39	32	59	40	48	37	32
Stone	2	4	2	2	1	1	2
Persistent litter	3	2	1	11	4	5	32
Nonpersistent litter	47	59	35	34	40	41	20
Moss and lichen	3	3	0	1	4	9	4
Vascular vegetation	6	1	3	12	3	7	10
SHRUB COVER							
Artemisia tridentata tridentata	1.3	0.3					
Artemisia tripartita	19.5	13.2			20.7	18.8	29.2
Chrysothamnus viscidiflorus	4.0	1.2	1.6	5.3	0.4	0.2	0.8
Purshia tridentata	3.9	4.4			1.8	2.4	3.4
Shrub total	28.7	19.1	1.6	5.3	22.9	21.4	33.4

Moss and Lichens.

Moss and lichen coverage declined following the prescribed fire treatment from initial preburn low levels (Table 1). A recovery of the cyrptogramic soil crust was noted during the third postburn season. Control coverage for this parameter has fluctuated at very low levels and probably reflects more the differences in data collection between sampling teams than changes in actual coverage.

Artemisia tridentata tridentata, basin big sagebrush.

Artemisia t. tridentata was an uncommon shrub scattered throughout the study area. As a member of the dominant shrub overstory its response to the prescribed fire treatment is of interest. On Burn Transect 1 the occurrence and coverage of this species was eliminated by the prescribed fire treatment (Tables 1 and 2, Appendix 2). The shrub was first recorded on the control transect in 1986 possibly indicating that outside the treatment area basin big sagebrush is still continuing a slow increase (Table 3).

Even though *Artemisia t. tridentata* was absent from the control transect during the early portion of the study it was evident that this species experienced a negative impact from the prescribed fire treatment.

Artemisia tripartita, three-tip sagebrush.

The shrub *Artemisia tripartita* was the dominant species in the superior stratum of the study site. Three-tip sagebrush declined in frequency but not in coverage during the baseline sampling periods on Burn Transect 1 (Tables 1 and 2, Appendix 2). The decline in frequency was likely due to irregularity in the exact placement of resampling plots. No evidence of a natural decline was noted during this time period. Frequency, coverage and above ground biomass (Table 4) indices declined even further after the prescribed fire. Frequency measurements indicated a few surviving sagebrush plants following treatment. These survivors had increased in occurrence slightly by the third postburn season. The percent coverage index failed to detect the presence of these few remaining plants. Control transect frequency and coverage data for this shrub have fluctuated, but remained at relatively high levels (Tables 2 and 3).

The changes recorded after the treatment show that the prescribed fire treatment had a significant negative impact on the *Artemisia tripartita* population within the study area. One-hundred percent of the tagged shrubs of this species failed to survive in the survival/mortality study indicating that this shrub has a very poor ability to resprout in this study area (Appendix 3). A remnant population still exists from plants either not burned and killed, or that have resprouted and survived. These surviving shrubs will contribute to the long-term diversity of the community composition and shrub age-class structure on the site.

Table 2. Species frequency for the Laidlaw Park Burn Unit Burn Transect 1 (1982-1986), Shoshone District, Idaho BLM. Prescribed fire treatment occurred on September 15, 1983.

	1982				1983				1984				1986			
Plot size (cm.)	5x5	25x25	25x50	50x50	5x5	25x25	25x50	50x50	5x5	25x25	25x20	50x50	5x5	25x25	25x50	50x50
SHRUBS																
Artemisia tridentata tridentata		2.5	2.5	2.5				2.5								
Artemisia tripartita	1.3	11.3	23.8	36.3	1.3	12.3	18.8	23.8				6.3		2.5	3.8	8.8
Chrysothamnus viscidiflorus		13.8	21.3	30.0	1.3	13.8	21.3	38.8	1.3	6.3	13.8	31.3	3.8	12.5	16.3	26.3
Purshia tridentata		1.3	1.3	1.3				1.3								
GRASSES																
Agropyron smithii	3.8	46.3	56.3	67.5	7.5	46.3	50.0	56.3	6.3	65.0	76.3	82.5	21.3	75.0	81.3	82.5
Bromus tectorum	36.3	73.8	82.5	83.8	47.5	77.5	80.0	80.0	8.8	77.5	87.5	92.5	16.3	42.5	51.3	56.3
Oryzopsis hymenoides								1.3								
Poa nevadensis			1.3	2.5			1.3	1.3								2.5
Poa sandbergii	12.5	32.5	37.5	41.3	3.8	21.3	26.3	32.5	3.8	16.3	27.5	30.0	1.3	8.75	16.3	26.3
Stipa thurberiana		1.3	2.5	3.8		2.5	3.8	3.8		1.3	1.3	2.5			2.5	2.5
FORBS																
Agoserus spp.										2.5	2.5	2.5	13.8	45.0	53.8	56.3
Allium accuminatum		1.3	1.3	2.5		1.3	2.5	2.5	1.3	8.8	17.5	23.8		13.8	20.0	27.5
Amsinckia spp.				1.3						1.3	3.8	3.8				
Arabis spp.						5.0	8.8	15.0					1.3	3.8	5.0	8.8
Chenopodium spp.										5.0	6.3	7.5				
Collinsia parviflora									2.5	58.8	67.5	76.3		7.5	12.5	15.0
Cordylanthus ramosus				2.5												
Epilobium paniculatum										2.5	2.5	4.0	1.3	8.8	12.5	18.8
Erigeron spp.				1.3								2.5			1.3	2.5
Erigonum spp.		1.3	1.3	1.3												
Gayophytum racemosum										23.8	37.5	52.5				

Table 2. (Continued)

Plot size (cm.)	1982 5x5	1982 25x25	1982 25x50	1982 50x50	1983 5x5	1983 25x25	1983 25x50	1983 50x50	1984 5x5	1984 25x25	1984 25x20	1984 50x50	1986 5x5	1986 25x25	1986 25x50	1986 50x50
FORBS (continued)																
Gymnosteris nudicaulis													5.0	27.5	42.5	53.8
Lactuca serriola											2.5	2.5	1.3	25.0	32.5	50.0
Lappula redowski								1.3					10.0	46.3	56.3	61.3
Lomatium triternatum								1.3						6.3	11.3	13.8
Machaeranthera canescens												1.3				
Microseris spp.													33.8	77.5	81.3	86.3
Mirabilis spp.										1.3	2.5	2.5				
Phacelia heterophylla				1.3				1.3			1.3					
Phlox hoodii		5.0	8.8	11.3		3.8	11.3	18.8	1.3	2.5	2.5	2.5		6.3	12.5	23.8
Phlox longifolia		5.0	8.8	12.5	1.3	11.3	18.8	25.0	5.0	33.8	47.5	48.8		16.3	17.5	22.5
Polygonum spp.								1.3								
Sisymbrium altissiumum		2.5	6.3	8.8			1.3	1.3	1.3	8.8	13.8	23.8	22.5	80.0	81.3	86.3
Tragopogon dubius																1.3
Annual forb		7.5	7.5	10.0	5.0	28.8	41.3	48.8		2.5	5.0	6.3				
Perennial forb		5.0	8.8	15.0						4.0	4.0	6.3				

Table 3. Species frequency for the Laidlaw Park Burn Unit Control Transect 1 (1983-1983), Shoshone District, Idaho BLM.

	1983				1984				1986			
Plot size (cm.)	5x5	25x25	25x50	50x50	5x5	25x25	25x50	50x50	5x5	25x25	25x50	50x50
SHRUBS												
Artemisia tridentata tridentata										1.3	1.3	2.5
Artemisia tripartita		13.8	31.5	47.5	1.3	20.0	25.0	60.0	5.0	18.8	30.0	50.0
Chrysothamnus nauseosus		1.3	1.3	2.5								
Chrysothamnus viscidiflorus		2.5	7.5	13.8		2.5	6.3	18.8		2.5	6.3	12.5
GRASSES												
Agropyron smithii	3.8	53.8	75.0	88.8	2.5	57.5	72.5	82.5	6.3	60.0	72.5	77.5
Bromus tectorum	7.5	40.0	50.0	58.8	3.7	40.0	48.8	52.5	10.0	32.5	40.0	52.5
Carex filifolia	2.5	17.5	21.3	31.3					3.8	20.0	23.8	31.3
Elymus cinereus									1.3			
Koeleria nitida		8.8	17.5	31.3	1.3	5.0	16.3	18.8		26.3	31.3	38.8
Poa nevadensis		1.3	3.8	5.0								
Poa sandbergii	5.0	36.3	51.3	60.0	5.0	30.0	45.0	83.3	5.0	38.8	51.3	70.0
Sitanion hystrix		2.5	3.8	5.0				1.3				
Stipa comata		3.8	7.5	11.3		1.3	2.5	2.5				
Stipa thurberiana		2.5	3.8	5.0		1.3	2.5	5.0	1.3	2.5	6.3	15.0
FORBS												
Allium accuminatum			2.5	5.0						3.8	6.3	6.3
Agoseris spp.									7.5	35.0	46.3	57.5
Antennaria spp.		1.3	2.5	3.8					1.3	5.0	6.3	15.0
Arabis spp.		1.3	2.5	8.8					1.3	2.5	2.5	5.0
Astragalus spp.												1.3
Collinsia parviflora					13.8	30.0	60.0	62.5		12.5	12.5	17.5
Cordylanthus ramosus		2.5	6.3	11.3		10.0	22.5	38.8				
Draba spp.	20.0	71.3	77.5	81.3								
Epilobium paniculatum									1.3	11.3	16.3	22.5

Table 3. (Continued)

Plot size (cm.)	1983				1984				1986			
	5x5	25x25	25x50	50x50	5x5	25x25	25x50	50x50	5x5	25x25	25x50	50x50
FORBS (continued)												
Erigeron spp.		1.3	5.0	5.0						5.0	10.0	15.0
Eriogonum spp.												1.3
Gymnosteris nudicaulis									4.0	45.0	56.3	75.0
Lactuca serriola										7.5	17.5	28.8
Lappula redowski									1.3	5.0	6.3	6.3
Lomatium triternatum										2.5	3.8	10.0
Microseris sp.									25.0	68.8	81.3	82.5
Phlox hoodii	1.3	17.5	28.8	37.5	1.3	12.5	30.0	52.5		17.5	26.3	35.0
Phlox longifolia	1.3	11.3	20.0	31.3	1.3	28.8	41.3	50.5	3.8	41.3	51.3	57.5
Sisymbrium altissiumum									1.3	16.3	20.0	35.0
Tragopogon dubius		2.5	3.8	5.0					1.3	5.0	6.3	10.0
Annual forb						36.3	47.5	53.8				

Table 4. Production and litter measurements (dry weight in lbs/ac) for the Laidlaw Park Burn Unit (1983-1984), Shoshone District, Idaho BLM. Prescribed fire treatment occurred on September 15, 1983.

	Burn Transect 1		Control Transect 1	
	1983	1984	1983	1984
Artemisia tripartita	494.6	2.0	291.6	430.0
Chrysothamnus viscidiflorus	27.7	77.0	16.2	9.0
Purshia tridentata	238.5			
Shrub Subtotal	760.8	79.0	307.8	439.0
Agropyron smithii	38.7	315.0	73.5	62.0
Bromus tectorum	263.5	132.0	50.7	14.0
Carex spp.			9.0	4.0
Koeleria nitida	2.4		11.7	21.0
Poa nevadensis			9.0	
Poa sandbergii	33.6	14.0	19.2	26.0
Sitanion hystrix	0.8	2.0	1.8	2.0
Stipa thurberiana		1.0		17.0
Agoserus spp.		1.0		
Allium accuminatum		3.0	3.6	7.0
Antennaria rosea			1.0	
Arabis spp.			2.4	
Astragalus spp.			2.4	7.0
Comandra pallida		10.0		9.0
Cordylanthus ramosus	2.4	2.0	3.8	42.0
Draba spp.			3.0	
Epilobium paniculatum	1.5	6.0	1.5	3.0
Gayophytum recemosum		32.0		
Lactucca serriola				2.0
Lomatium triternatum		2.0		1.0
Machaeranthera canescens	2.4		1.5	
Phlox hoodii	49.2	14.0	51.1	90.0
Phlox longifolia	4.2	11.0	14.4	11.0
Sisymbrium altissimum		164.0		
Trapapogon dubius	3.6	26.0	2.0	17.0
Annual spp.	4.8		9.0	
Herbaceous Subtotal	407.1	735.0	270.6	189.0
Litter Subtotal	1922.0	461.0	1362.0	910.0
Total	3089.9	1275.0	1940.4	1538.0

Chrysothamnus viscidiflorus, green rabbitbrush.

Green rabbitbrush was a minor shrub component in the shrub/grassland ecosystem at the study site. Coverage for Chrysothamnus viscidiflorus dropped during the second baseline sample period, then remained stable at that lower level through the first postburn sample (Table 1). In 1986 the coverage again returned to a level slightly greater than the original baseline measurement. Rabbitbrush coverage on the control transect has fluctuated at very low levels.

Frequency levels indicated a slight increase in rabbitbrush on Burn Transect 1 during the baseline sampling seasons (Table 2, Appendix 4). A slight decline occurred following the prescribed fire treatment. The frequency decline has continued into the third postburn growing season.

Above ground biomass for the shrub on the treated transect climbed significantly the first season following treatment (Table 4, Appendix 4). The control transect declined for this index. No additional biomass data in more recent years has been collected by the district.

Overall Chrysothamnus viscidiflorus experienced a small positive impact from the treatment. The increase in biomass and coverage appear to be attributable to the prescribed fire treatment. The decline in frequency may also be related to the treatment but was also duplicated by a similar decline on the control. The control decline would tend to indicate a reason other than the prescribed fire for the treatment transect decline in frequency.

Purshia tridentata, antelope bitterbrush.

Bitterbrush was another uncommon shrub in the overstory that is an important wildlife browse. Various ecotypes of this shrub have differing capabilities to resprout following top damage. Purshia was only measured by the line intercept coverage data collection. After treatment the shrub was eliminated adjacent to the burned transect (Table 1). The plant was severely impacted by the prescribed fire with 95% of the tagged shrubs of this species in the survival/mortality study failing to resprout (Appendix 3). No remeasurement of mortality was made for this shrub in subsequent seasons.

Agropyron smithii, western wheatgrass.

The dominant native perennial grass, Agropyron smithii has increased in frequency on both the treatment and control transects (Tables 3 and 3, Appendix 5). The treatment transect experienced a significant increase in frequency the season following the fire and has remained stable at that higher level. The control has shown a steady but slow increase in frequency.

Western wheatgrass above ground biomass increased over seven times the first postburn season over the previous preburn level (Table 4, Appendix 5). This graminoids biomass on the control transect remained relatively unchanged during the same time period. No more recent biomass measurements have been made.

The prescribed fire treatment had a significant positive impact on the frequency and above ground biomass levels of western wheatgrass. No other plant species at this location increased in such a dramatic manner that was clearly attributable to the treatment. In the survival /

mortality study 10% of the tagged plants of this species failed to survive through the first postburn sampling period (Appendix 3). By the third postburn season 25% of the tagged plants had died. The large postburn response more than compensated for the 25% mortality, assuming the measurement is an accurate reflection of the fire kill ratio.

Bromus tectorum, cheatgrass.

Bromus tectorum was the most common graminoid within the treated area and remained at relatively stable frequency levels on both the treatment and control transects until the 1984 first postburn season (Tables 2 and 3, Appendix 6). The 1986 frequency sample for this species has shown a decline on both transects. Above ground biomass for cheatgrass dropped significantly between 1983 and 1984 on both treatment and control sites (Table 4).

The prescribed fire treatment had very little effect if any on the Bromus tectorum population in the treatment area. Frequency and above ground biomass patterns were identical for the control and treatment transects indicating an influence other than the prescribed burn. It is unknown what may have caused the recently measured declines in the indices. I was told by the District Range Conservationist that the decline appears to be affecting a larger area than just the treatment site.

Poa sandbergii, Sandberg's bluegrass.

Poa sandbergii frequency levels have continued in a steady, but slow decline on the prescribed fire treatment transect (Table 2, Appendix 7). This decline appears to have begun before the treatment and is evident during the two baseline samples. Control transect frequency levels have fluctuated but remained at relatively high levels (Table 3). Very minor changes were observed in above ground biomass measurements for this species; a slight decline on the treatment transect and a similar small increase on the control (Table 4).

Very little evidence is apparent to indicate that the decline on the treatment transect is related to the prescribed fire. Most of the total frequency decline were recorded prior to the treatment. The fire appears to have had neither a negative or positive impact on this graminoid at this point in the study.

Stipa thurberiana, Thurber's needlegrass.

Thurber's needlegrass is an uncommon graminoid at his location and frequency measurements have remained relatively unchanged from their baseline low levels (Tables 2 and 3). Above ground biomass for Stipa thurberiana increased on both the control and treatment transects, the control experiencing the greatest degree of change (Table 4).

The survival/ mortality data indicated that 15% of the tagged live plants were dead by the end of the first postburn growing season (Appendix 3). Another 35% of the remaining plants were noted as having damaged crowns, presumably from the treatment. Mortality rose to 25% by the end of the third postburn season.

The survival / mortality study presents evidence of a substantial impact to mature bunches of Thurber's needlegrass by the prescribed

fire. The stable frequency levels for the graminoid indicate that the overall mortality has not been as severe as indicated or that seedling establishment after the fire has been substantial enough to overcome the loss of part of the mature plant population. As a result there is no evidence of any long-term negative impact on this grass by the prescribed fire from the available data, and the possibility of a positive impact if seedling establishment has been enhanced.

Phlox hoodii, Hood's phlox.

Hood's phlox initially declined in frequency after the prescribed fire treatment while during the same time period the control transect index was increasing for this forb (Tables 2 and 3, Appendix 8). The treated transect has since increased in frequency, while the control has declined. Since the baseline measurements there has been a net increase in the frequency level on the burned transect. The control transect has shown little net change since the baseline data was collected. Above ground biomass for the forb initially declined on the burned area as the control biomass for Hood's phlox increased (Table 4). No biomass measurements are available for the third postburn season response.

The prescribed fire treatment had an initial negative impact on Hood's phlox that may have since recovered with a slight net positive result for occurrence.

Phlox longifolia, longleaf phlox.

Frequency measurements for Phlox longifolia initially increased on both the control and treatment transects one season after the prescribed fire (Tables 2 and 3, Appendix 9). Since that first postburn season the frequency levels on both transect have declined. The treated transect has shown the greatest amount of fluctuation, but both transects have shown little net change from the baseline data. Above ground biomass for longleaf phlox increased the first postburn season on the treated transect, while control transects either increased or remained unchanged (Table 4).

The fluctuations on both transects have near identical response patterns indicating that the prescribed fire treatment was not the reason for the changes in frequency. It is uncertain if the burning may have accented the response on the treatment transect. No impact is evident on this forb from the treatment after the third postburn growing season.

Other forbs of interest.

Several annual forbs have increased in their frequency measurements since the prescribed fire treatment (Table 2). Tumblemustard (Sisymbrium altissiumum) has continued to increase following treatment form very low preburn levels. Groundsmoke (Gayophytum racemosum) appeared for the first time during the first postburn monitoring and had disappeared by the third postburn season. Groundsmoke has not been recorded as occurring on the control transect. The appearance and fidelity of these two annual forbs was positively impacted by the prescribed fire treatment, and in the case of groundsmoke may be a significant factor in the life cycle and maintenance of this annual plant.

Conclusions

Nearly complete removal of the shrub stratum was achieved by the prescribed fire treatment. A remnant population of Artemisia tripartita remains within the treated area on microsites which escaped the fire. Very little evidence was obtained to support this shrubs reputed ability to resprout after being top-killed by fire. Artemisia t. tridentata, a minor co-dominant shrub was eliminated based on the monitoring information. Chrysothamnus viscidiflorus increased in shrub biomass and coverage but has decreased slightly in frequency and does not appear to be presenting a management problem as has been reported on other prescribed burns.

The herbaceous stratum has increased in above ground biomass due primarily to postburn changes by the dominant grass, Agropyron smithii, and forb components (Table 4, Appendix 10). Few species in the herbaceous layer exhibited significant changes in frequency due to the treatment, principal changes were experienced by the dominant grass and a few annual forbs.

III. Holborn Burn Units, Elko District, Nevada BLM.

Introduction

On the Holborn prescribed burn site the Elko district has maintained data collection on two treatment transects and one control transect. The allotment is an Artemisia tridentata tridentata - Poa sandbergii / Agropyron spicatum community being managed for use by both livestock and wildlife. Baseline data for the monitoring transects were collected in 1982. Initial ignition of the units was on September 21, 1983 at which time these two treatment transects were burned under the following prescribed fire parameters;

Temperature - 70°F,
Relative Humidity - 15%,
Windspeed - 1 to 3 miles / hour,
Corrected Reference Fuel Moisture - 3%,
Live Sagebrush Moisture - 93%,
Soil Moisture - 8%

(other prescribed fires were conducted in later years). The treatment transects were read annually for postburn information during the 1984 - 1986 growing seasons. For the 1985 - 1986 seasons there is no control data with which to compare the treated transects that had been prescribed burned. This lack of control data makes interpretation of changes on the treated areas after the first postburn growing season difficult to directly attribute to the fire.

Results

Important vegetal and abiotic components from the Holborn site will be presented to examine the changes which have occurred during the study period. Plant species whose indices have changed little from the baseline data or for which there is limited information will not be discussed but are available for examination on the data tables. The influence of the prescribed fire treatment upon these components will be evaluated, keeping in mind the limited control data for nontreatment comparison.

Bare ground and litter.

Percent bare ground was not measured during the baseline sampling by the district. On one treatment transect (HF1) percent bare ground was estimated with the assumption that all other components had been sampled. On the second transect (HF3) it was apparent that not all components had been measured, only the prominent graminoids, so the bare ground extrapolation was not possible. Later sampling on transect HF3 was more complete but is only representative of the first season postburn condition. No coverage data was collected for the control transect to present comparable on-site untreated changes.

The estimated preburn bare ground percent coverage for treatment transect HF1 was 77% (Table 5, Appendix 11). Measured vegetal coverage was approximately 28%, with the remaining coverage attributable to the litter component. The percentage of bare ground increased the season

Table 5. Percent cover for the Holdorn Burn Unit (1982-1986), Elko District, Nevada BLM. Prescribed fire treatment occurred on September 21, 1983.

	H-1, (Treatment, Unit 2)				H-3, (Treatment, Unit 1)			
	1982	1984	1985	1986	1982	1984	1985	1986
Ground Cover								
Bare ground	76.7*	85.1	72.0	62.7		64.3	#	#
Litter	5.4	4.5	4.0	0.8		2.3		
Shrub Cover								
Artemisia tridentata wyomingensis	11.9							
Chysothamnus viscidiflorus	4.2	17.8	4.9	8.4		2.4		
Herbaceous Cover								
Agropyron smithii		1.1		2.4				
Agropyron spicatum	0.1				1.2	3.3		
Agropyron dasystachyum			1.9					
Allium spp.		0.2						
Astragalus spp.			0.3					
Bromus tectorum		0.1				1.9		
Balsamorhiza spp.						0.9		
Crepis acuminata						0.6		
Lupinus spp.	0.1	0.6	1.0	4.4				
Phlox spp.	0.4		13.2	18.3				
Phlox longifolia						0.1		
Phlox hoodii		2.8				1.1		
Poa sandbergii	0.4	0.1	0.2			1.5		
Oryzopsis hymenoides								
Sitanion hystrix	0.7	0.7	1.3	1.8				
Stipa thurberianna					1.0	0.2		
Annual forbs	0.1	0.6	2.2	0.9				

*Not measured, assumed as residual to equal 100%.
#Discontinued, lack of baseline data

following treatment to 85% and vegetation declining to approximately 10%. Litter coverage remained relatively unchanged. After that first postburn season the coverage of bare ground declined below the baseline measurement with corresponding increases in vegetal coverage. The majority of these later postburn increases in vegetal cover are attributable to the herbaceous, and in particular the forb, species. The amount of litter coverage has declined with each subsequent data collection possibly indicating an increase in biomass turnover on the study site. Reasons for the possible increase in the turnover rate are unknown. Plausible explanations for this phenomenon could be either different interpretations of the component by the data collection team, an increase in available on-site moisture leading to more rapid decay, or increased removal by insects (principally mound building ants). It is assumed that these various changes in coverage were induced by the treatment though there is no comparable control data to substantiate that observation.

Artemisia tridentata wyomingensis, Wyoming big sagebrush.

Wyoming big sagebrush declined significantly in frequency on both treated transects following the prescribed fire treatment (Table 6, Appendix 12). A small decline was also noted for the control transect. Both treatment transects have maintained remnant populations of sagebrush which escaped the fire. Sagebrush canopy coverage on the two treatment transects follows trends observed from the frequency data (Table 5).

Sagebrush above ground biomass measurements were absent from the 1986 treatment samples and control biomass has not been resampled at all (Table 7). From the 1986 data sheets it is not apparent if sagebrush was totally absent from the biomass transects or was intentionally not collected. However since the there appears to have been major changes in sagebrush frequency and coverage on the treatment transects, it would be a safe assumption to conclude that sagebrush biomass has also been significantly reduced within these same areas.

The prescribed fire treatment has evidently created a mosaic of burned and unburned shrub vegetation on the Holborn allotment. Where the Wyoming big sagebrush component was burned there was a negative impact on the frequency and coverage of the shrub species, and presumably on the shrub above ground biomass as well. Along the two treatment transects only scattered remnant populations of sagebrush remain.

Chrysothamnus viscidiflorus, green rabbitbrush.

Green rabbitbrush has maintained approximately the same postburn frequency levels (small increases with each sample period) as were established during the baseline line data collection (Table 6, Appendix 12). A small decline in control transect rabbitbrush frequency was measured. This shrub has experienced a slight increase in percent canopy coverage on the treated transects since the original preburn data was collected (Table 5).

Above ground biomass on treatment transect HF1 for *Chrysothamnus viscidiflorus* had increased approximately 3700% the third postburn season over the baseline data level (Table 7). Treatment transect HF3

Table 6. Species frequency (30" x 30" plot size) for the Holborn Burn Units (1983-1986), Elko District, Nevada BLM. Prescribed fire treatment occurred on September 21, 1983.

	HF1 (Treatment, Unit 2)				HF3 (Treatment, Unit 1)				HF4 (Control, Unit 2)	
	1983	1984	1985	1986	1982	1984	1985	1986	1983	1984
SHRUBS										
Artemisia tridentata wyomingensis	50	5	10	10	35	2	3	3	24	15
Chrysothamnus viscidiflorus	28	24	28	30	32	30	33	36	6	3
GRASSES										
Agropyron smithii	12	38	37	33					4	2
Agropyron spicatum	2	4	3	5	41	51	48*	55	14	19
Bromus tectorum		5	1	11	18	98	46	21	74	79
Elymus cinereus	1	1	1	1					4	6
Poa sandbergii	7	3	9	5	50	65	68	63	7	14
Sitanian hystrix	19	25	33	37	17	31	24	28	61	76
Stipa thurberianna					27	32	31	31	19	7
Orzopsis hymenoides		1	1	3					2	1
FORBS										
Allium spp.	28	90	71	83						
Astragalus spp.		16		4	13	28	42	44		
Balsamorhiza spp.	1	1	2	1	9	11	11	13	1	
Comandra spp.									13	
Crepis acuminata					6	25	23	33		
Delphinium spp.	1	18	1	16						
Lomatium spp.	1									
Lupinus spp.	4	17	17	16					7	4
Orthocarpus spp.	1									
Opuntia spp.									2	3
Phlox spp.	79									
Phlox longifolia		90	93	98	2	9	8	7		
Phlox hoodi		39	38	43	18	18	27	28		
Tragopogon dubius	1									
Annual forbs	49	60	49	93	2	5	12	54		49
Perennial forbs			13	1		1	3	1		30

*Different, unspecified frame size.

Table 7. Vegetative production (dry weight in lbs/ac) for the Holborn Burn, Elko District, Nevada BLM. Prescribed fire treatment occurred on September 21, 1983.

	H-1 (Treatment, Unit 2)		H-3 (Treatment, Unit 1)	
	1983	1986	1983	1986
Agropyron spicatum	15.8	12.0	50.6	179.4
Agropyron dasystachyum	0.8	92.0	6.1	
Bromus tectorum	35.7	+	120.4	27.1
Elymus cinereus	45.9	56.1	55.7	35.8
Poa sandbergii	6.7	5.0	6.1	22.7
Sitanion hystrix	51.0	15.2		18.4
Stipa thurberiana	5.4		12.6	54.6
Subtotal grasses	161.3	180.3	251.5	338.0
FORBS				
Allium spp.	1.3	71.7		0.4
Aster spp.			0.4	
Astragalus spp.	1.1	2.2	6.8	232.1
Balsamorhiza spp.		4.7	0.3	21.6
Brassica spp.		86.5		
Comandra spp.	36.8		40.5	
Crepis acuminata	3.1	98.2		49.3
Eriogonum spp.			0.8	
Lepidium spp.			8.7	
Lupinus spp.	30.3	22.5		
Orthocarpus spp.	9.8			
Phlox hoodii	33.9	67.5	0.6	30.6
Phlox longifolia		7.8		
Annual forbs		33.2		2.7
Subtotal forbs	116.3	394.3	51.1	336.7
SHRUBS				
Artemisia t. wyomingensis	422.6		627.6	
Chrysothamnus viscidiflorus	9.8	373.1	48.4	170.3
Subtotal shrubs	432.4	373.1	676.0	170.3
Total	710.0	947.7	985.6	845.0

during the same time period increased 252% in above ground biomass. No control transect data was available for this index for comparison.

The prescribed fire treatment probably has caused the increases in above ground biomass evident on the treated transects, though without control data we can not be certain another variable created the effect. The increase in canopy coverage experienced by the treatment transects would be indicative of an increase in shrub biomass. Unfortunately, again there is no control data to evaluate if the control transect rabbitbrush cover also changed and to determine if the effect was related to the prescribed fire. This shrub has not increased in frequency levels in a manner that would indicate an impact by the treatment. If the biomass increase is treatment related that could be considered a positive, but temporary impact by the fire to the shrub. Otherwise there does not appear to be any significant impact caused by the treatment.

Agropyron smithii, western wheatgrass.

Western wheatgrass occurred on treatment transect HF1 and the control transect. Transect HF1 had a significant increase in frequency the first postburn season, which has gradually declined in later samples (Table 6, Appendix 13). The control transect was slightly reduced in frequency the first postburn season from a previously low baseline sample. This graminoid species was not recorded using any other indices.

The limited data available for western wheatgrass would indicate a large positive impact caused by the prescribed fire treatment. The effect of this treatment appears to be declining with time.

Agropyron spicatum, bluebunch wheatgrass.

Bluebunch wheatgrass occurred on all three transects, but only on treatment transect HF3 could the graminoid be considered common. Frequency levels on HF3 have increased since the treatment and have fluctuated at these higher levels (Table 6, Appendix 13). HF1 initially was lower in frequency the first postburn season but has increased in occurrence the two seasons following. The control transect was shown to increase in *Agropyron spicatum* frequency slightly between 1982 and 1984.

The above ground biomass for bluebunch wheatgrass has remained stable on HF1 while increasing 254% on HF3 (Table 7). The larger biomass increase was more conspicuous on HF3 because the grass was much more frequent in that location.

Where bluebunch wheatgrass is a relative prominent component of the herbaceous layer the prescribed fire treatment had a positive impact. On transect HF1 which is either marginal for the presence of this grass species, or through management it has been replaced by other grasses, the effect of the fire treatment was no greater than changes measured on the control transect.

Bromus tectorum, cheatgrass.

The low frequency levels of *Bromus tectrom* on the one treatment transect upon which it occurred, HF1, have fluctuated considerably since the initial baseline measurements were made (Table 6, Appendix 14). The

grass was not measured in the baseline data and first appeared after the treatment. Low frequency levels were maintained until the third postburn season at which time occurrence went up to 11%. The presence of this grass on the control transect has been considerably higher than the index for the treatment transect and has also increased.

The appearance and increase of cheatgrass on treatment transect HF1 after the prescribed fire on first observation would seem to be treatment related. However, the increase is similar to measurements on the control which would be related to an influence other than the fire. More recent control transect data on this important, alien problem species would have been helpful in evaluating the species response. The prescribed fire treatment has had either a very minor positive impact, or no impact at all on the occurrence of cheatgrass within the study area.

Forbs.

The principal forb species have shown varying frequency responses (Table 6). Balsamroot (Balsamorhiza spp.) has remained essentially unchanged. Tapertip hawksbeard (Crepis accuminata) has shown steady increases in frequency. Milkvetch (Astragalus spp.) has increased significantly on one transect while fluctuating erraticly on the other treatment transect (Appendix 15). Lupine (Lupinus spp.) frequency initially increased following the prescribed fire and have stabilized at those higher levels. Longleaf phlox (Phlox longifolia) frequency levels have increased and remained at the higher levels while Hood's phlox (Phlox hoodii) occurrence appears to have remained stable (Appendix 16). Initial baseline data for the two phlox species is difficult to interpret because of the "lumping" of the two species together.

Above ground biomass for individual forbs is difficult to interpret because of the small sample sizes (Table 7). A few of the genera that were recorded with major changes between the preburn and 1986 data are presented; Allium increased, Astragalus increased, Brassica increased, Comandra decreased, Crepis increased significantly on both transects, and both Phlox species increased. On both treatment transects total forb above ground biomass had increased the third postburn season over the preburn baseline level.

The prescribed fire treatment has had a positive impact on the forb population as a whole and on many of the forb species individually. A majority of the species responded favorably with increasing frequencies and/or biomass (Appendix 17). Forb species which had been "lumped" as annual forbs showed substantial increases in frequency levels above the preburn baseline data.

Conclusions

From the limited data available it appears that the shrub stratum, principally Wyoming big sagebrush was severely impacted by the prescribed fire treatment. A minor shrub component, green rabbitbrush, appears to have been favorably impacted and has remained at constant frequency levels while increasing in coverage and above ground biomass. This species has not become a management problem at the Holborn allotment as it has been indicated to have been at other prescribed fire locations.

The herbaceous coverage and biomass of the treated transects have increased above their preburn levels indicating a positive impact on these species. Most herbaceous plants have experienced changes in their frequency levels with the overall net change being a positive impact by the treatment at this time.

IV. Whitehorse Burn Units, Vale District, Oregon BLM.

Introduction

Two treatment transects were prescribed burned during September 7 and 10, 1983 within the Whitehorse grazing allotment (Artemisia t. tridentata / Agropyron spicatum h.t.) under the following prescribed fire parameters;

	Sept. 7, 1983	Sept. 10, 1983
Temperature -	85°F	?,
Relative Humidity -	26%	?,
Corrected Reference Fuel Moisture -	3 to 7%	4 to 5%,
Live Sagebrush Moisture -	112%	99%,
Soil Moisture -	7%	7%.

A single control transect was established within a protected area that lay between the two burn units in the allotment. Baseline vegetation data was obtained for the two treatment transects during the 1982 growing season, the control transect was established and first read in 1983. Frequency, coverage and production measurements were collected on these transects by BLM Range Conservationists to monitor changes in vegetative structure and composition over time to evaluate the effectiveness of the prescribed fire treatment.

Results

Each of the important plant and abiotic classifications that were sampled will be evaluated as to their change in status on the transects as indicated by the various indices. Coverage measurements, obtained by the line intercept method, did not include the items bare ground and litter. Only shrub and prominent graminoid species were measured for evaluation of coverage changes. Above ground biomass measurements were limited to graminoid species.

Artemisia tridentata tridentata, basin big sagebrush.

The shrub stratum of the Whitehorse allotment contained basin big sage as the dominant shrub in the baseline data collection. On both transects the frequency of this shrub were reduced significantly immediately following the prescribed burning treatment (Table 8, Appendix 18). All sagebrush was removed from Burn Transect 1 while a small remnant population has remained on Burn Transect 2. This remaining population has increased slightly in frequency during the three season since the fire. On the control transect the frequency level for sagebrush has remained relatively stable over the entire study period.

Coverage measurements for sagebrush parallel the results obtained from the frequency data on the treated transects (Table 9). Coverage for sagebrush was considerably reduced by the treatment in those areas burned. The control transect sagebrush coverage remained

Table 8. Species frequency for the Whitehorse Burn Units (1982-1986), Vale District, Oregon BLM. Prescribed fire treatment occurred on September 7, 1983.

	Burn Transects																		Control Transect								
	1									2																	
	1982			1984			1986			1982			1984			1986			1983			1984			1986		
	25x25	25x50	50x50	25x25	25x50	50x50	25x25	25x50	50x50	25x25	25x50	50x50	25x25	25x50	50x50	25x25	25x50	50x50	25x25	25x50	50x50	25x25	25x50	50x50	25x25	25x50	50x50
SHRUBS																											
Artemisia tridentata tridentata	27	40	59							10	17	24	1	1	1	4	7	8	10	18	26	12	20	36	17	21	36
Chrysothamus viscidiflorus										5	9	11	5	6	9	4	7	9									
Chrysothamnus nauseosus																		1									
GRASSES																											
Agropyron spicatum	25	33	44	30	42	67	26	37	53	29	45	60	30	39	58	32	43	58	22	29	42	27	40	57	28	38	48
Festuca idahoensis	2	5	8	2	7	7	4	6	9			1								1	1					1	1
Poa sandbergii	90	96	96	83	91	97	96	98	98	78	84	88	51	67	71	79	84	89	88	93	94	91	95	98	95	95	97
Sitanion hystrix	3	11	19							2	3	5							3	4	5	1	1	1	1	1	1
FORBS																											
Annual spp.	90	94	98	85	91	96	99	99	99	59	75	85	76	88	95	100	100	100	100	100	100	98	99	99	100	100	100
Perennial spp.	41	57	71	26	34	36	43	61	77	25	42	64	20	25	30	60	74	78	76	88	92	60	73	87	66	82	95

Table 9. Percent cover for the Whitehorse Burn Units and Control (1982-1986), Vale District, Oregon BLM. Prescribed fire treatment occurred on September 7, 1983.

	Burn Transects						Control		
	1			2					
	1982	1984	1986	1982	1984	1986	1983	1984	1986
Shrub Cover									
Artemisia tridentata tridentata	8.8			10.3	1.3	3.6	13.4	12.4	8.8
Chrysothamnus nauseosus				2.6					
Chrysothamnus viscidiflorus					1.2	4.3			0.6
Herbaceous Cover									
Agropyron spicatum	2.9	2.2	1.3	0.6	1.6	1.5	0.7	1.0	0.3
Sitanion hystrix	0.1	0.1	0.1	0.1			0.1		

essentially unchanged from 1983 through 1984 and had declined by approximately one-third in 1986. This presents evidence of a decline in control sagebrush vigor separate from the treatment response.

The prescribed fire treatment had a strong, immediate negative impact on the presence and coverage of *Artemisia t. tridentata*. Areas which remained unburned within the treated area have sagebrush remaining. However, these remaining areas of sagebrush are limited in scope and generally occur where the soil was thin and rocky with limited herbaceous biomass to fuel the fire spread.

Chrysothamnus viscidiflorus and *C. nauseosus*, rabbitbrush.

These two species of rabbitbrush were only recorded on Burn Transect 2 and are generally uncommon throughout the study area. Rabbitbrush frequency levels have been stable on this one treatment transect throughout the study (Table 8). The low preburn coverage initially recorded during the baseline data collection decreased even lower the season following treatment (Table 9, Appendix 19). By the third postburn season the rabbitbrush coverage was slightly greater than the preburn level.

Without rabbitbrush occurring on the control transect it is impossible to determine if the fluctuation in shrub coverage were attributable to the treatment. The presumed greater shrub growth reflected by the increase in the coverage index would be an expected response to the reduced levels of shrub stratum competition, and increased levels of moisture and nutrients available to the resprouting shrub species within the treated study area.

Agropyron spicatum, bluebunch wheatgrass.

Agropyron spicatum has shown little change in frequency from the baseline level after three postburn growing seasons (Table 8, Appendix 20). Burn Transect 1 showed a slight increase in frequency, while Burn Transect 2 has declined slightly. Both treatment transect changes are small enough to be attributable to either normal long-term shifts in species specific population levels or error induced by different data collectors. Frequency changes recorded on the treatment transects for this grass were less of a change than the reduction which was measured on the control transect.

Percent cover for *Agropyron spicatum* has declined on Burn Transect 1 and the control (Table 9). Burn Transect 2 has experienced an increase in coverage of the graminoid.

Above ground biomass increased dramatically for bluebunch wheatgrass on all transects the growing season following the prescribed fire treatment (Table 10). This increase in biomass was also evident on the control transect. Burn Transect 1 had the greatest level of change (407%), while Burn Transect 2 and the control transect had lower but similar biomass changes (219% and 215% respectively). Biomass levels dropped to slightly above the rested preburn levels the third postburn season and reflect the return of postburn livestock grazing to the allotment.

None of the measured indices for *Agropyron spicatum* have shown a clear response at this point in time that can be directly attributable to the prescribed fire treatment. Certainly no negative impacts were

Table 10. Graminoid production (dry weight in lbs/ac) measurements for Whitehorse Burn Units and Control (1982-1986), Vale District, Oregon BLM. Prescribed fire treatment occurred on September 7, 1983.

	Burn Transects						Control		
	1			2					
	1982	1984	1986	1982	1984	1986	1983	1984	1986
Agropyron spicatum	26	132	48	21	67	36	20	63	27
Festuca idahoensis	11	10	11		6	2			
Sitanion hystrix	13		14			2	10		
Total	50	142	73	21	73	40	30	63	27

recorded on the treatment transects for this graminoid. Changes on the treatment transects were either mimicked by the control transect, or were insignificant changes that may be due to normal fluctuations in plant populations. The biomass data fails to delineate between the influences of differing treatments (prescribed fire and grazing) and at this time shows no response that can be specificly shown to have been induced by the prescribed burning.

Poa sandberdii, Sandberg's bluegrass.

Poa sandbergii was the most frequently occurring graminoid in the Whitehorse allotment. Initial declines recorded the first postburn season on the treatment transects were followed by frequency levels returning to or above the preburn levels the third postburn season (Table 8, Appendix 21). The control transect has shown a slight, but continual increase in frequency over the baseline data level recorded in 1983.

Percent coverage and the above ground biomass for Poa sandbergii were not recorded, leaving frequency as the only index for evaluating fire effects on this graminoid. The prescribed fire treatment had an initial negative impact on the bluegrass which has since recovered to approximately preburn levels. The degree of recovery on the treated transects has shown a net positive response approximately equal to the positive change recorded for this grass on the control over the last four growing seasons. Based on this data the treatment transects would possibly have had higher frequency levels of bluegrass at this time if they had remained untreated by prescribed fire.

Festuca idahoensis, Idaho fescue.

Festuca idahoensis was a relatively uncommon, almost rare, graminoid in the Whitehorse allotment. Burn Transect 1 and the control transect frequencies for the fescue have remained stable, while the single recorded fescue on Burn Transect 2 disappeared following treatment (Table 8). No coverage measurements were obtained for this species, possibly due to its infrequent status. Above ground biomass levels were to low to develop an accurate concept of the treatment response, but appear to have remained stable on Burn Transect 1 (Table 10).

The small amount of evidence available indicates that no positive or negative response was achieved by the treatment for this particular species. The disappearance on Burn Transect 2 may, or may not be due to the treatment. Either way the loss of a single plant is of little significance to the rangeland ecosystem as a whole.

Sitanion hystrix, squirrel-tail.

Sitanion hystrix was another uncommon graminoid in the study area. This grass has apparently been eliminated in the frequency plots on the two treatment transects (Table 8). A decline in frequency was also observed for this grass on the control transect between the 1983 - 1984 seasons. This control transect decline appears to have stabilized in 1986 at a very low frequency level.

Percent coverage measurements for squirrel-tail have remained constant along Burn Transect 1 (Table 9). Remeasurement failed to show

this species presence on Burn Transect 2 and the control in the following seasons.

Above ground biomass data for Sitanion hystrix is highly variable depending on plot location, a trait to be expected for uncommon species (Table 10). Many gaps appear in the data when no plant of this species was located in a sampling plot.

Sitanion data for the Whitehorse allotment is too limited to make an accurate judgement on the species response to the prescribed fire treatment. The decline in frequency may be due in part to the treatment, but a decline is also evident on the control and may be due to another unknown influence or vector.

Annual Forbs.

The occurrence of annual forb species was very high on all three transects. This group of forbs has shown a slight increase over baseline levels in frequency following the prescribed fire treatment on Burn Transect 1 (Table 8, Appendix 22). The second treatment transect has exhibited relatively large progressive increases in frequency for this group since treatment. While the treated transects were increasing in frequency levels the control transect has maintained a stable, but high level of occurrence for the annual forb group. This group of plants were not recognized in the data collection for coverage and above ground biomass. The prescribed fire treatment has promoted a positive response in the increased presence of annual forbs in the allotment.

Perennial Forbs.

Perennial forbs were also grouped for data collection by the BLM District personnel. Frequency data shows a decline in perennial forbs on the treated transects the growing season following the prescribed fire (Table 8, Appendix 22). By the third postburn season the perennial forb frequency levels on the treated transects were higher than the preburn baseline levels. An identical pattern of perennial forb presence was also measured on the control transect during the sampling period. This forb group was not recognized for data collection in the coverage and biomass indices. From the frequency data alone there does not appear to have been either a positive or a negative response to the prescribed fire treatment by the perennial forb group. It is unknown how individual species within this group responded, a positive response by one forb species could have been counteracted by a decline in another species showing no net change. The limited data set indicates normal fluctuations not attributable to the prescribed fire treatment.

Conclusions

Comparisons between the 1982 preburn baseline data and the 1984 and 1986 postburn data show a dramatic change in the shrub stratum indices within the Whitehorse prescribed burn unit. A highly significant decrease in frequency and coverage for the dominant shrub Artemisia t. tridentata was recorded on the two treated transects. Very little change was measured for this shrub the first postburn season on the control transect. Declines in sagebrush coverage on the control

transect the third postburn season indicate an influence on shrub vigor in the Whitehorse allotment other than the prescribed fire treatment. The shift in resource allocation from the previously dominant shrub stratum in the treated areas will have long-term impacts on the herbaceous layer formerly beneath those shrubs. Assuming that there is no long-term changes in the structure and composition of the herbaceous stratum in the treated area, an unlikely situation as the grasses and forbs compete with each other for space and resources; the increased availability of the herbaceous stratum alone will promote a better distribution in grazing impacts by both wild and domesticated ungulates within the treated area. With proper grazing management this can be very favorable response to the creation of a diverse and healthy mosaic of shrub and grassland habitat.

Initial results (first and third years postburn) indicate a more mixed response to the treatment than was evident in the superior vegetal layer. Only the annual forb group appears to have achieved a positive response to the prescribed fire treatment. Poa sandbergii showed an initial decline attributable to the treatment but current data suggests a rapid recovery. The uncommon grass Sitanion hystrix may also have been damaged by the treatment but the results are not clear because of the few specimens involved. Agropyron spicatum, Festuca idahoensis and the perennial forb group appear to have experienced little impact by the treatment.

Evaluation of the forb groups is complicated by the "lumping" of species into the two categories resulting in lost information. It is impossible to distinguish a particular forb species that may have increased or declined as a result of the treatment. This type of information may be important if a particular forb is a prominent component of a wildlife diet, is a noxious weed or poisonous to livestock.

The initial large postburn increase, and corresponding third postburn season decline measured in above ground biomass, most of which was composed of Agropyron, was duplicated by similar trends in the graminoid biomass on the control transect (Table 10, Appendix 23). The data from the biomass measurements is complicated by the influence of renewed grazing on the three transects. While all three transects experienced above ground biomass increases and later declines, the treated transects have experienced the largest overall increase in biomass.

V. Northridge Burn Unit, Vale District, Oregon BLM.

Introduction

The entire Northridge unit was prescribed burned on September 14, 1983 under the following prescribed fire parameters;

Temperature - 78°F,
Relative Humidity - 23%,
windspeed - 3 to 4 miles / hour,
Corrected Reference Fuel Moisture - 4 to 7%,
Live Sagebrush Moisture - 127%,
Soil Moisture - 9%.

Four transects, three treatment and one control, were established and read the growing season prior to the fall prescribed fire to create a preburn baseline vegetation data set. All three treatment transects were successfully burned. Frequency, coverage and mortality / survival measurements were remeasured on the four transects each subsequent postburn season.

Results

Vegetal components from this site on the Vale District are presented and discussed in relation to the prescribed fire treatment. On-site abiotic components were not measured.

Artemisia tridentata wyomingensis, Wyoming big sagebrush.

Wyoming big sagebrush was the dominant shrub on the prescribed fire site. Sagebrush occurrence on treatment transects 1 and 2 were not recorded in subsequent remeasurements after the prescribed fire treatment (Table 11, Appendix 24). This shrub was also significantly reduced in frequency after the treatment period on treatment transect 3. The residual population of Wyoming big sagebrush has remained relatively stable at these lower levels with a very slight increase in frequency occurring on the most recent sample. Frequency measurements for this shrub on the control transect have been very stable except for a slight decline during the 1986 data collection.

Density measurement results generally compliment the frequency data but appear to be more sensitive to actual on-site changes (Table 12, Appendix 25). Density measurements indicted that a residual population of Wyoming big sagebrush still existed the first postburn season on treatment transects 2 and 3. This population was no longer present by the second postburn season. This index also shows a gradual, but steady decline in sagebrush density on the control transect. This information was not evident from the frequency data.

Coverage by Wyoming big sagebrush again generally complimented the frequency data on the treatment transects (Table 13, Appendix 26). The control transect has had a gradual increase in coverage since the baseline data was established.

The prescribed fire treatment has had a significant negative impact

Table 11. Species frequency (20" x 20" plot size) for the Northridge Burn Unit (1983-1986), Vale District, Oregon BLM. Prescribed fire treatment occurred on September 14, 1983.

	Burn Transects												Control Transect			
	1				2				3							
	1983	1984	1985	1986	1983	1984	1985	1986	1983	1984	1985	1986	1983	1984	1985	1986
Shrubs																
Artemisia t. wyomingensis	29				29	1			27	8	10	14	26	27	26	14
Artemisia tripartita					14	1										
Chrysothamnus nauseosus	1								3	1						
Grasses																
Agropyron spicatum	24	33	37	33	47	51	52	56	13	13	9	16	10	15	16	17
Sitanion hystrix						4										
Stipa thurberiana									62	77	66	82				
Forbs																
Lupinus spp.	48	86	90	81	37	69	62	69	5		4	11	44	52	71	73

Table 12. Shrub density for the Northridge Burn Unit (1983-1986), Vale District, Oregon BLM. Prescribed fire treatment occurred on September 14, 1983.

	Burn Transects												Control Transect			
	1				2				3							
	1983	1984	1985	1986	1983	1984	1985	1986	1983	1984	1985	1986	1983	1984	1985	1986
Artemisia t. wyomingensis	49				73	5			39	16		16	94	82	74	73
Artemisia tripartata					67	2										
Chrysothamnus nauseosus									2	1		1	2	2		1

Table 13. Percent cover for the Northridge Burn Unit (1982-1986), Vale District, Oregon BLM. Prescribed fire treatment occurred on September 14, 1983.

	Burn Transects												Control Transect			
	1				2				3							
	1982	1984	1985	1986	1982	1984	1985	1986	1982	1984	1985	1986	1982	1984	1985	1986
SHRUBS																
Artemisia t. wyomingensis	16.9				7.4				5.7				7.5	7.9	10.3	10.6
Artemisia tripartita					11.8											
Chrysothamnus nauseosus									0.4				0.3	0.4		
HERBACEOUS COVER																
Agropyron spicatum	1.4	1.3	2.7	3.4	1.2	1.3	2.2	2.4		0.3		0.3	0.5	0.6	1.0	1.3
Lupinus spp.	17.0	3.7	11.5	14.5	12.8	13.8	11.9	16.9	4.9		1.8	1.9	8.5	8.6	7.4	11.5
Poa sandbergii						0.9		+		0.3		+		1.7		+
Stipa thurberiana									1.2	0.7	1.6	3.0				

on this dominant canopy shrub at the Northridge site. Most of the sagebrush population was killed by the treatment. Residual populations that were stressed by the treatment have died. Plants that were missed by the fire have survived. These dramatic changes were not evident for the sagebrush on the control transect which have shown minor changes over the four years of data collection.

Artemisia tripartita, three-tip sagebrush.

Three-tip sagebrush was a prominent shrub only on scattered microsites within the Northridge burn unit and only appeared within the data on treatment transect 2. On this transect frequency measurements indicated the shrub had a residual postburn population which disappeared by the second postburn season (Table 11, Appendix 24). Density measurements along the same transect also show the residual sagebrush population being eliminated during this same time period (Table 12, Appendix 25). Coverage measurements for three-tip sagebrush were no longer evident the first postburn season and did not reflect the remnant plants left on site (Table 13, Appendix 26). Mortality / survival studies performed with this shrub species also validated the surviving remnant population which subsequently died by the second postburn season (Appendix 27).

While there was no control data collected to monitor changes in three-tip sagebrush populations outside the treated area, it was very clear that the prescribed fire treatment had a severe negative impact on this particular species. The ability to resprout was evident on a small portion of the population. However, for unknown reasons these new shoots were not able to survive more than the first postburn growing season.

Chrysothamnus nauseosus, rubber rabbitbrush.

Rubber rabbitbrush was a very minor shrub component on two treatment transects and the control transect. However, this shrub genus has presented problems on other prescribed fire rangeland projects and as a result is a shrub of management concern. Because of this concern rabbitbrush is presented in this documentation even though its overall importance in the ecosystem being examined is low. Frequency measurements alone would have indicted that this shrub disappeared from all transects where it had formerly occurred, including the control, the first postburn season (Table 11, Appendix 28). The shrubs occurrence was low enough that canopy coverage also failed to indicated the plants status (Table 13). Density was more successful in indicating population trends and showed a general decline for rabbitbrush that does not appear to be related to the prescribed fire treatment (Table 12).

Agropyron spicatum, bluebunch wheatgrass.

The dominant graminoid at the Northridge site was bluebunch wheatgrass. Frequency levels for bluebunch wheatgrass have gradually increased on all transects (Table 11, Appendix 29). Relatively large increases were evident on treatment transects 1 and 2 the first postburn season and on treatment transect 3 the third postburn season. The control transect frequency level has been increasing slowly at a

nonsignificant rate.

Coverage by Agropyron spicatum during the third postburn season was nearly double the preburn baseline level on two of the three treatment transects (Table 13). Coverage on the control for the same time period has nearly tripled. The year to year changes on these transects have been insignificant because of the low levels of change, but do represent a positive change over the baseline situation.

Bluebunch wheatgrass was selected to be part of the mortality /survival study by the Vale District. No mortality was shown by the tagged grass bunches through the first and second postburn seasons, though some plants were obviously stressed by the treatment (Appendix 27). The third postburn remeasurement had shown that 20% of the population being evaluated died and that these had been the previously stressed plants.

The prescribed fire treatment has not had much of an impact on the bluebunch wheatgrass population at the Northridge site. Frequency levels are up on all transects, in spite of mortality that was likely induced by the treatment. Coverage has also increased on all transects, more on the control than the treated transects.

Stipa thurberiana, Thurber's needle-grass.

Thurber's needlegrass was only present on microsites within the unit and appears only in data collected from treatment transect 3. The grass was a species of concern for the district and is included in this discussion because they expressed an early interest in the impact of fire on this particular species.

On the one transect that the grass occurred the very low frequency levels have gradually increased each postburn measurement (Table 11, Appendix 30). The district has indicated that a large number of Thurber's needle-grass seedlings were evident following the treatment. Coverage has nearly tripled since the prescribed fire treatment (Table 13). The mortality / survival study did not have any Stipa plants dying from the prescribed fire, but some mortality was evidenced from burial by ground squirrels (Appendix 27).

Because no control data was available for comparison it is not known if the positive response indicated by Thurber's needle-grass after the treatment was actually related to the prescribed fire. No treatment induced negative impact was noticed on the monitor population.

Lupinus spp., Lupine.

Lupine was the only forb recorded on any of the transects at the Northridge site. As a result the response of this forb gains in significance beyond the possibility of the its presenting potential management problems for some grazing animals. Frequency measurements for lupine on two treatment transects increased the first postburn season and have remained relatively stable at those higher levels (Table 11, Appendix 31). On treatment transect 3 lupine was very uncommon initially and though increasing in frequency still remains uncommon. Frequency levels on the control transect have also been gradually increasing. Lupine experienced no major long term changes in coverage after three postburn seasons on any of the four transects (Table 13, Appendix 31). During the season immediately following the treatment,

two of the treatment transects had declines in coverage by lupine but have recovered in later seasons.

Very little impact by the prescribed fire treatment has been evidenced for lupine at this location. Frequency and coverage measurements on the treatment transects have shown similar general trends exhibited by the control transect. Declines in coverage and increases in frequency on two treatment transects may have been accented by the treatment.

Conclusion

The shrub stratum, composed principally of Wyoming big sagebrush and three-tip sagebrush was significantly and negatively impacted by the prescribed fire treatment. Most of the sagebrush component were eliminated. Rubber rabbitbrush, a minor shrub component, has also declined but is this is not necessarily attributable to the treatment.

In the herbaceous layer only the increases shown by Thurber's needlegrass may be due to the treatment, and there is no control data to substantiate that possibility. Other species have had similar trends evident on both treatment and control transects. During the time period of the study there have not been any long-term negative impacts on the herbaceous layer. All transects appear to be improving from the original baseline sample.

VI. Stone Creek and Timber Creek Units, Butte District, Montana BLM.

Introduction

There has not been any additional data collected from these two spring prescribed fires in the *Artemisia tridentata vaseyana* / *Festuca Idahoensis* habitat types. Only the first season postburn data was available on the Timber Creek Unit. Stone Creek had preburn and first season postburn data collected. These data and their associated problems have been previously discussed and will not be readdressed (see Section VIII., reference 25).

These two sites in Montana at the northern edge of the Great Basin presented a contrast to the prescribed burns conducted with the other cooperating BLM districts. Besides presenting results from a different subspecies of sagebrush and a different habitat type from the other locations; these two study areas in Montana also differed by being of relatively high elevation and precipition, steep slopes and treatment during a different phenological period. The district was able to accomplish these prescribed fires in a manner appreciably different than the fall fires at the lower elevation sites. The study sites selected by the Butte District are representatives of an important portion of the grazing resource in southwestern Montana. I would recommend that additional herbaceous fire effects data be collected in this habitat type to better supplement our management knowledge in the mountain grasslands and in particular the graminoids from the genera *Festuca* and *Stipa*.

VII. Conclusions on generalized fire effects within the sagebrush/grass ecosystem of the northern Great Basin area.

Prescribed burning within the sagebrush/grass ecosystem initiates a complex series of interrelating reactions to the treatment that will determine the site overall response. Predicting the response before the treatment is applied will be complicated by many unpredictable abiotic (examples are wind and precipitation) and biotic (examples include insect outbreaks and postburn ungulate grazing pressure) influences. There will be rare times when the best prepared management plan and applied treatment, no matter what that treatment may be, will be defeated by overwhelming negative influences that are beyond the control of the manager. However, that scenario can happen to any good land management activity and should be treated as a learning experience. The problems are then corrected to the best of our abilities and the program continues.

The northern Great Basin fall prescribed burning in sagebrush/grass case studies have provided us with a generalized picture of the short-term (3 year) fire effects response that can be expected. Differences in response and degree of response can be expected from each different site, but the general trends are important for planning purposes. Sites with unusual features such as rare plants or uncommon soil types may require additional evaluation before treatment, and more intensive monitoring to quantify the response.

We have observed from these prescribed fires that there is a temporary (2 - 3 year) increase in the coverage of bare ground following

a treatment. This increase in bare ground is caused by corresponding declines in both the coverage of the sagebrush-shrub component and the accumulated herbaceous/shrub litter on sites with slow decomposition rates. A postburn decline in coverage by the cyrptogramic soil crust also contributes to the amount of bare ground. The return to preburn levels of bare ground coverage is accomplished by increases in herbaceous vegetation coverage and the return of herbaceous litter. The slower return of the cyrptograms will be influenced by the species available for recolonization, postburn site characteristics and grazing intensity.

The shrub layer is severely impacted by the prescribed fire and the majority of this impact is mortality in the dominant shrubs, sagebrush. All indices showed rapid declines in sagebrush (basin big sagebrush, Wyoming big sagebrush, three-tip sagebrush) most of which was noticeable immediately after the treatment. Stressed plants usually died by the second postburn season. Three-tip sagebrush which has been classified as a weak resprouter also experienced high mortality in those plants which did manage to resprout the first postburn growing season. Remnant populations of sagebrush that remained after the prescribed fires were on microsites which had avoided the flames. These fall fires tended to leave few areas with remaining live sagebrush. Unburned shrubs were most common on sites with complex fuel beds and high levels of fuel discontinuity.

Less common shrub components included rubber rabbitbrush, green rabbitbrush and bitterbrush. The rabbitbrush on these sites tended to increase in coverage and biomass after the fire treatment. No major changes in shrub occurrence were observed over the three year postburn period. To some of the field observers rabbitbrush "appeared" to be more common than before the treatment. This observation is understandable when you consider that the shrubs were larger after the treatment and also more visible after the removal of the sagebrush component. Population monitoring showed that there was little change in occurrence due to the treatments. Bitterbrush only occurred on one study site and this erect ecotype experienced high mortality following the treatment. Very little resprouting was apparent after the fire which is consistent with the literature on this ecotype. The treatments impact on seedling germination and growth were not studied.

The short-term fire effects response of the herbaceous layer from these fall fires can be generally summed up in the first assumption made by Lyon and Stickney[1] in their preliminary model for predicting early forest succession after wildfire; "The majority of the plant species on site will survive and reestablish on the burn". The perennial grasses varied in their response from site-to-site, but in general they survived and increased in biomass over the preburn levels. Perennial grasses that had high reestablishment rates and evidence of increased biomass included both western wheatgrass and bluebunch wheatgrass. Thurber's needlegrass suffered fire damage to large, mature crowns and experienced moderate mortality, but also tended to increase overall in biomass and appears at least on one site to have had increased postburn germination

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[1] L. J. Lyon, P. F. Stickney, "Early vegetal succession following large northern Rocky Mountain wildfires" in Tall Timbers Fire Ecology Conference and Fire and Land Management Symposium, Number 14, chm. E. V. Komarek (Missoula, MT, 1974), p. 369.

success. Sandberg's bluegrass and Idaho fescue have shown very little change that were attributable to the treatment. The annual, cheatgrass also showed little short-term change that could be shown to be a fire effect.

Forb response varied to a large degree on the species life history and phenology. Annual forbs became more frequent on these sites after burning and their biomass increased accordingly as they occupied available landscape. This group of plants would have been the group to potentially influence site diversity. Annuals, and most likely biennuals, were "lumped' into a single category and any resultant change in diversity was unmeasureable. Perennial forbs as a group maintained their levels of occurrence, individually they fluctuated considerably which did not seem to be treatment related. Tapertip hawksbeard and milkvetch were prominent perennial forbs that increased in frequency. Varying responses were shown by Hood's phlox and longleaf phlox and may have been dependent on the intensity and degree of the plants that were burned. The two phloxs were the only perennial forbs with above ground live biomass at the time of treatment.

With the decline in sagebrush, increased area is available for colonization by herbaceous plants. There will be a long-term positive impact as perennial herbaceous plants succeed the annuals and biennuals which are taking advantage of the newly created space on these rangeland sites. The immediate increase in herbaceous biomass available to grazing ungulates by the removal of the sagebrush, the increase in herbaceous above ground production on particular sites and the potential for future colonization by grasses and forbs are positive impacts that will improve the grazing potential of the allotments. The changes in forb occurrence and biomass are positive impacts for particular wildlife species dependent on those plants. On-site changes in shrub cover will favor some wildlife species while discouraging others. The increased amount of ecotone created by the prescribed fires will be favorable to nearly all wildlife species and will tend to increase wildlife diversity adjacent to the treated area.

VIII. Previous reports completed in conjunction with the "Demonstration of Prescribed Burning on Selected BLM Districts Project" and associated Cooperative Agreements #22-C-3-INT-26 and #22-C-4-INT-33 (on file at the Intermountain Fire Sciences Laboratory, P.O. Box 8089, Missoula, MT 59807 unless otherwise specified).

1. Bushey, C.L. and B.M. Kilgore. 1984. Sagebrush-grass vegetative, fuel, and fire behavior parameters: Preliminary results from the Demonstration of Prescribed Burning on Selected BLM Districts Project. 97 p.

2. Bushey, C.L. 1985. A computer-aided fire prescription development process using empirical data from two Bureau of Land Management sagebrush/grass prescribed fires. 24 p. + 17 append.

3. Bushey, C.L. 1985. Summary of results from the Galena Gulch 1982 spring burns (Units lb). 8 p.

4. Bushey, C.L. 1985. Sagebrush-grass vegetative fuel and fire behavior parameters for prescribed fire. p. 316. In; Proceedings of the Wilderness Fire Symposium. November 15 - 18, 1984. Missoula, MT. USDA Forest Service General Technical Report INT-182. 434 p.

5. Bushey, C.L. 1985. First year postburn results from the Demonstration of Prescribed Burning on Selected Bureau of Land Management Districts. 28 p. + 46 append.

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7. Bushey, C.L. 1986. Comparison of observed and predicted fire behavior in the sagebrush/bunchgrass vegetation type. p. 187-291. In; Proceedings, Fire management, the challenge of protection and use. April 17 - 19, 1985. Utah State University, Logan, UT. 286 p.

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11. Bushey, C.L. 1986. Fire effects on the wildlife of the sagebrush-grass community - the burrowing owl. 7 p.

12. Bushey, C.L. 1986. Fire effects on the wildlife of the sagebrush-grass community - the American pronghorn. 20 p.

13. Bushey, C.L. 1986. Fire effects on the wildlife of the sagebrush-grass community - the Townsend's ground squirrel. 4 p.

14. Bushey, C.L. 1986. Fire effects on the wildlife of the sagebrush-grass community - the sage grouse. 13 p.

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18. Bushey, C.L. 1987. Fire effects on the wildlife of the sagebrush-grass community - the ferruginous hawk. 3 p.

19. Bushey, C.L. 1987. Fire effects on the wildlife of the sagebrush-grass community - the western rattlesnake. 4 p.

20. Bushey, C.L. 1987. Fire effects on the wildlife of the sagebrush-grass community - the prairie falcon. 3 p.

21. Bushey, C.L. 1987. Fire effects on the wildlife of the sagebrush-grass community - the Great Basin spadefoot toad. 2 p.

22. Bushey, C.L. 1987. Fire effects on the wildlife of the sagebrush-grass community - the sagebrush lizard. 3 p.

23. Bushey, C.L. 1987. Fire effects on the wildlife of the sagebrush-grass community - the Great Basin pocket mouse. 4 p.

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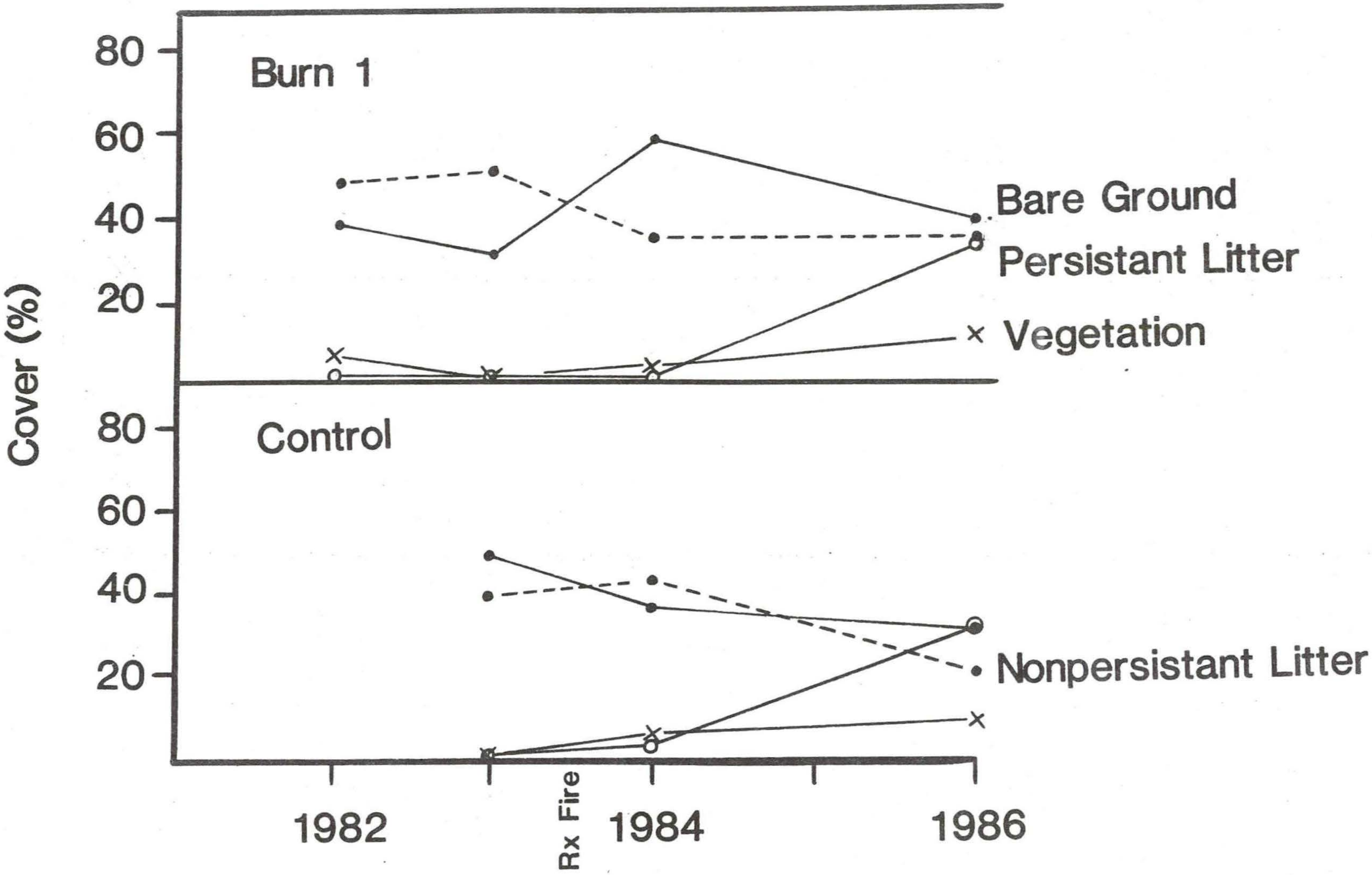
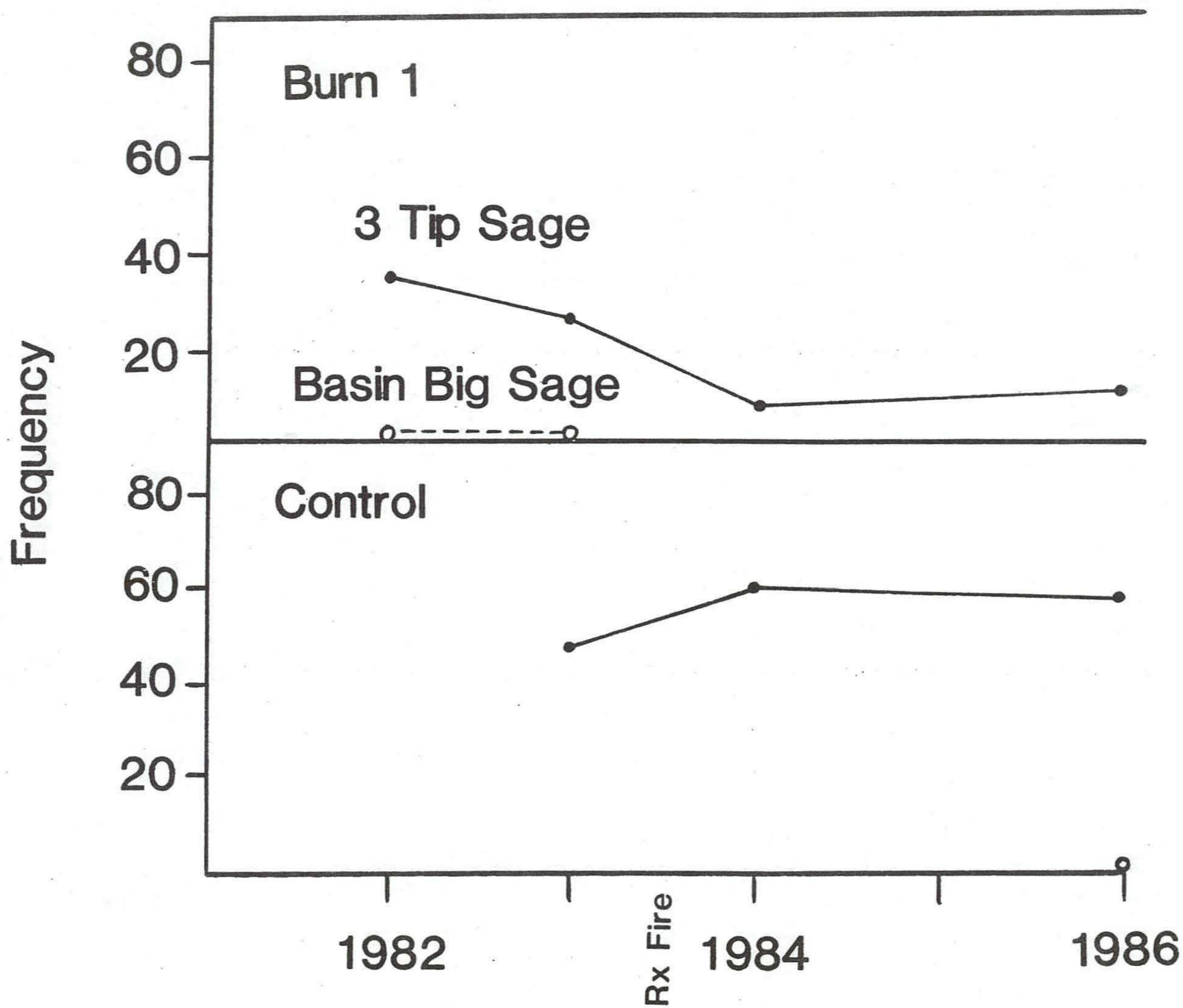
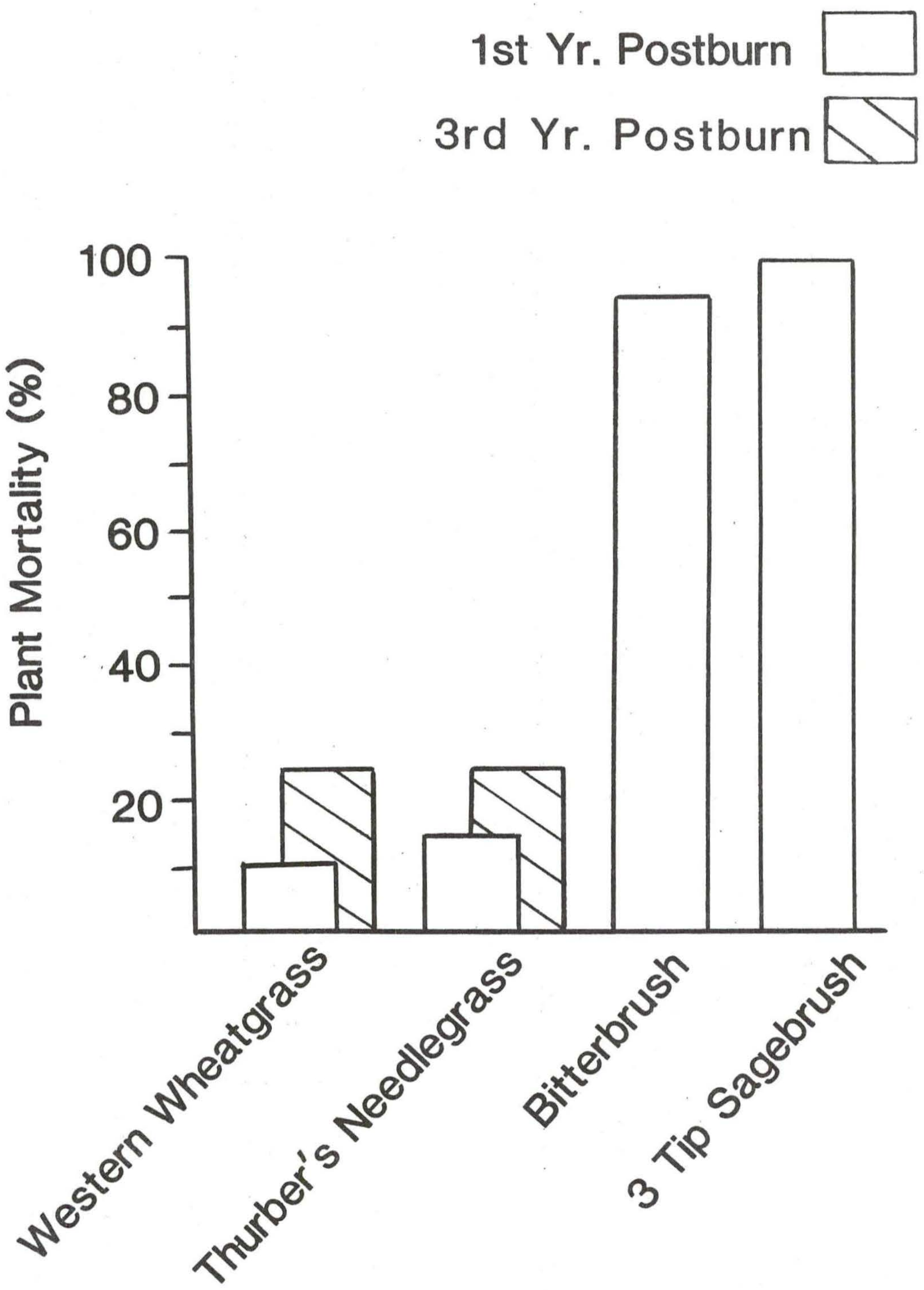


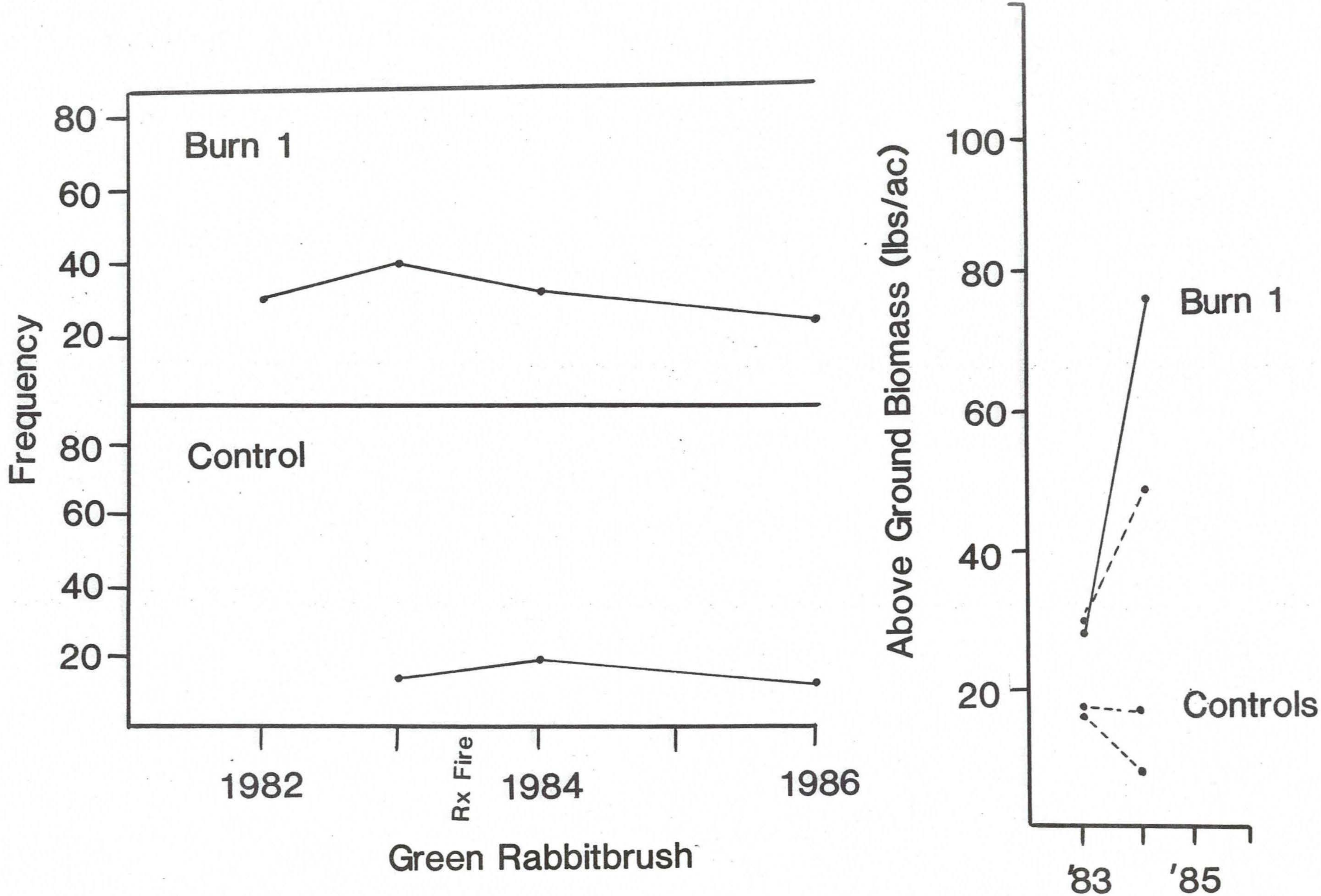
Appendix 1. Percent coverage of the bare ground, persistant litter, nonpersistant litter and vascular vegetation components from Laidlaw Park, Shoshone District, Idaho BLM.



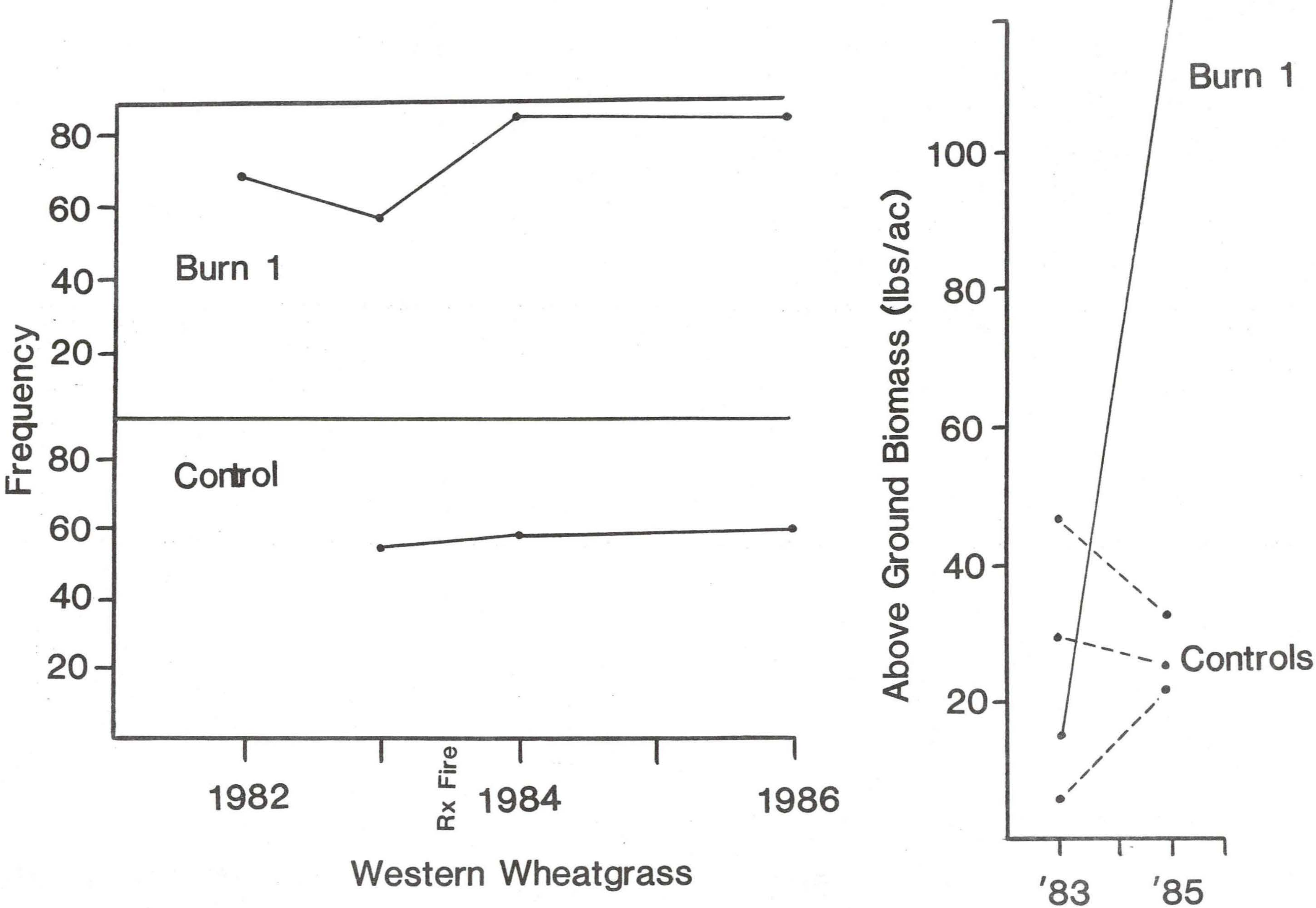
Appendix 2. Frequency measurements for sagebrush from Laidlaw Park, Shoshone District, Idaho BLM.



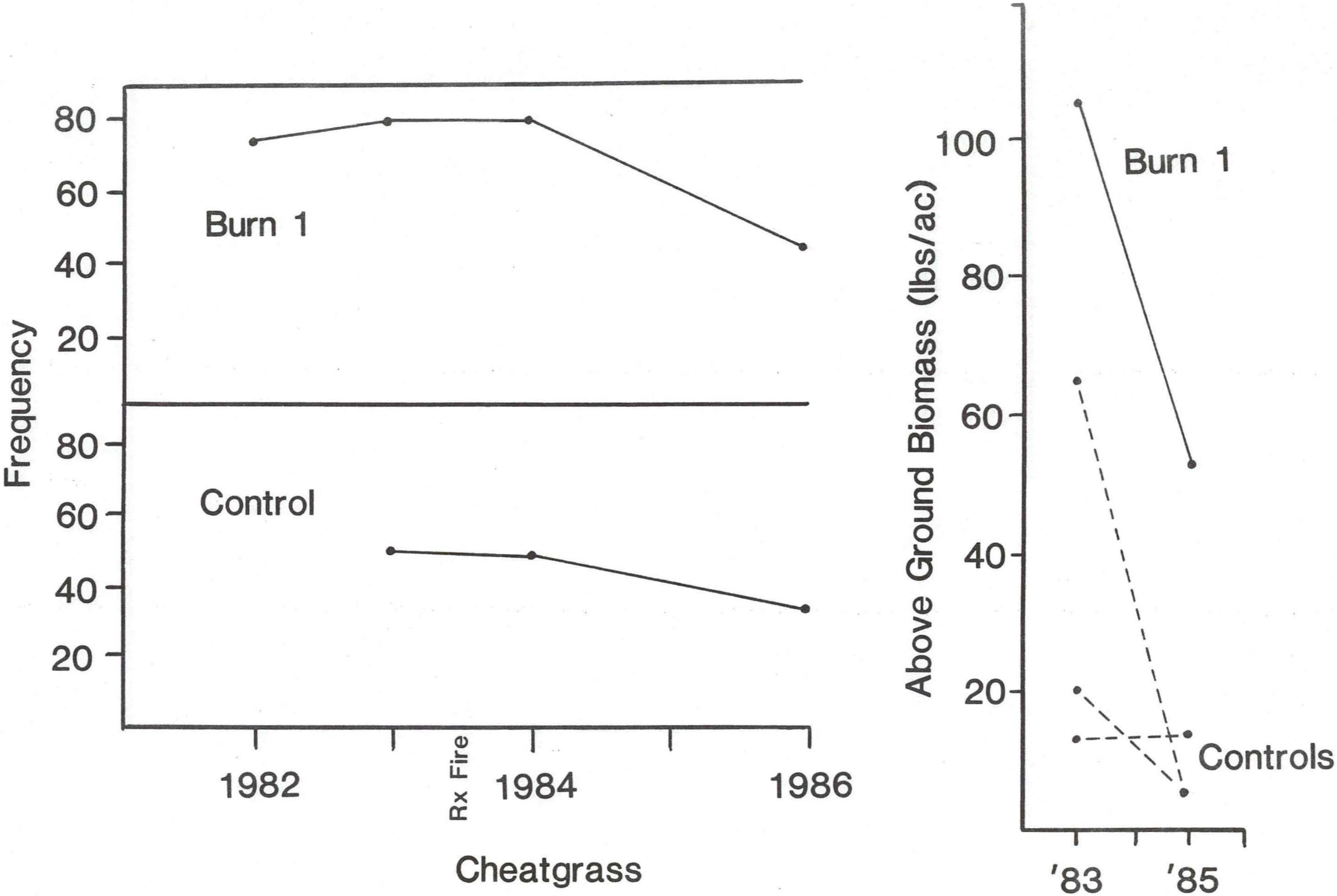
Appendix 3. Plant mortality / survival study from the Laidlaw Park prescribed fire treatment, Shoshone District, Idaho BLM.



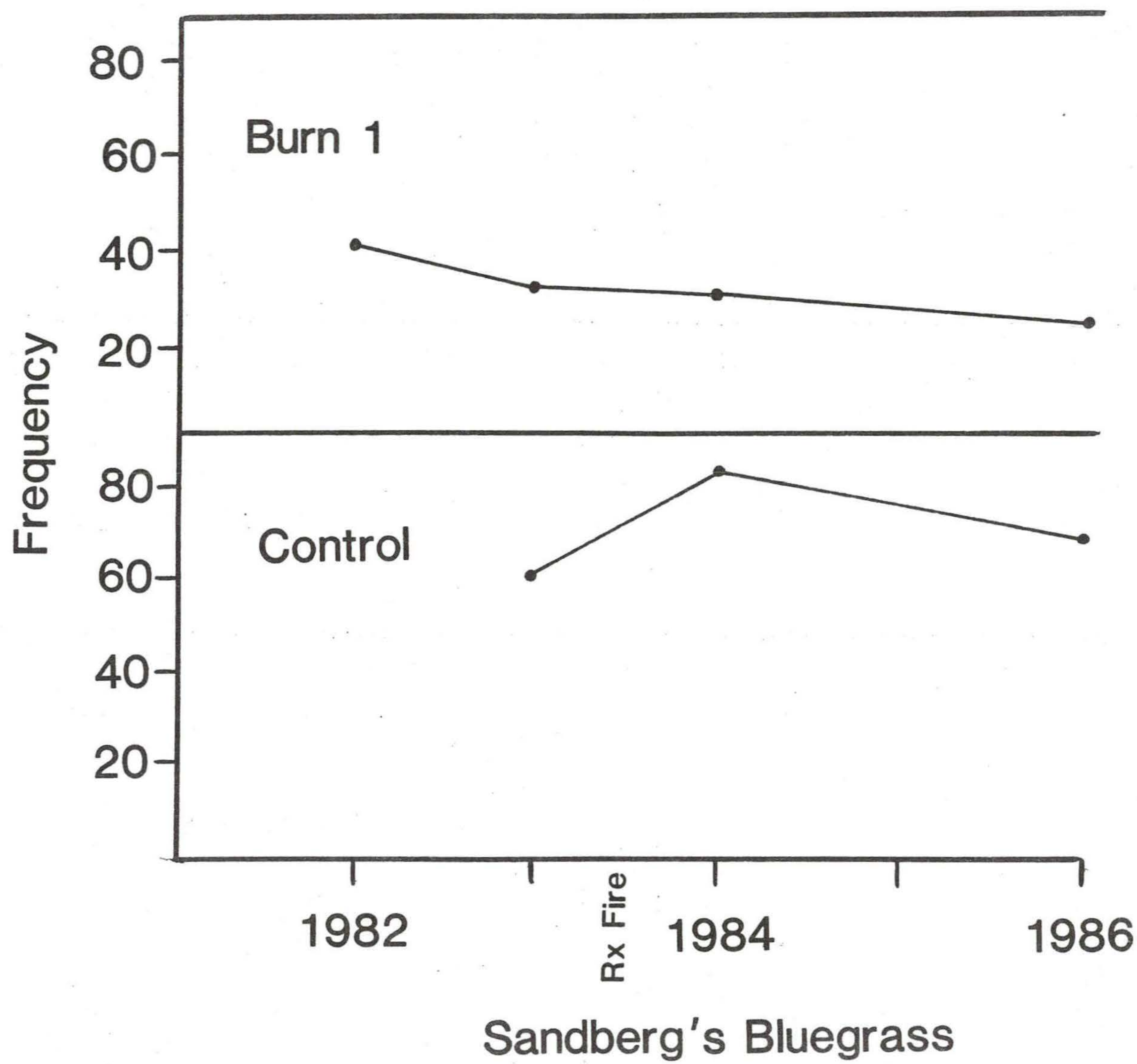
Appendix 4. Frequency and above ground biomass measurements for green rabbitbrush from Laidlaw Park, Shoshone District, Idaho BLM.



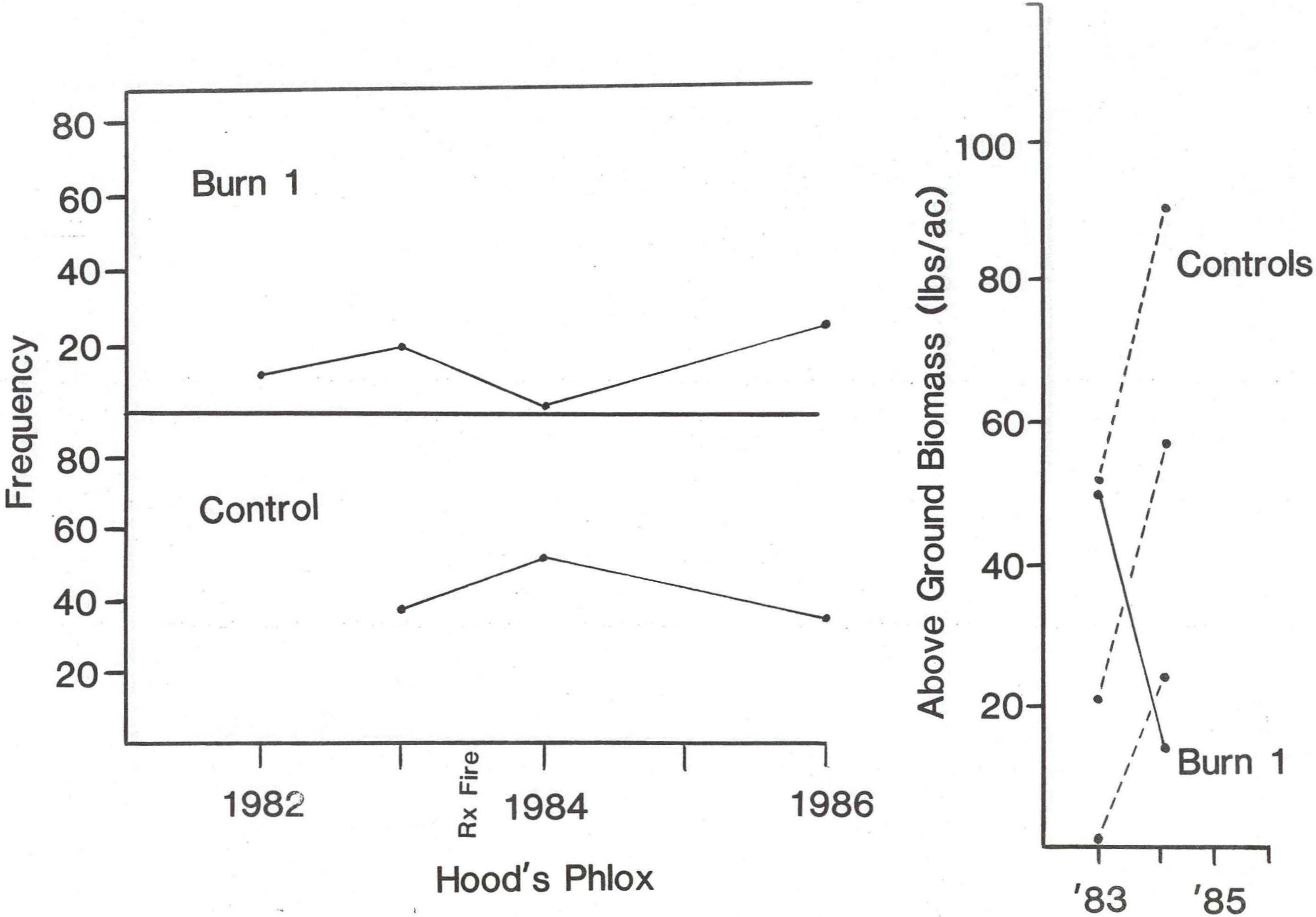
Appendix 5. Frequency and above ground biomass measurements for western wheatgrass from Laidlaw Park, Shoshone District, Idaho BLM.



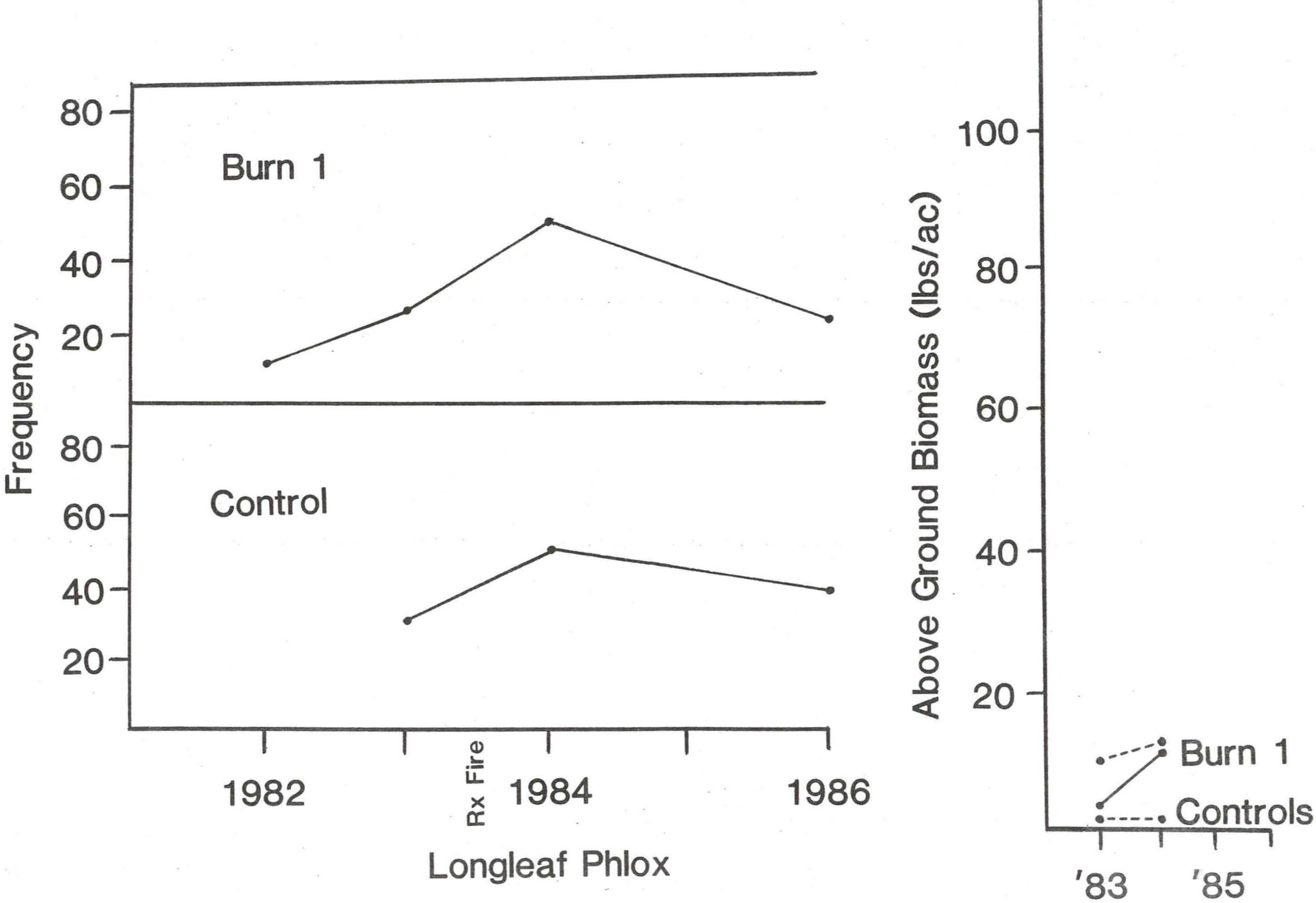
Appendix 6. Frequency and above ground biomass measurements for cheatgrass from Laidlaw Park, Shoshone District, Idaho BLM.



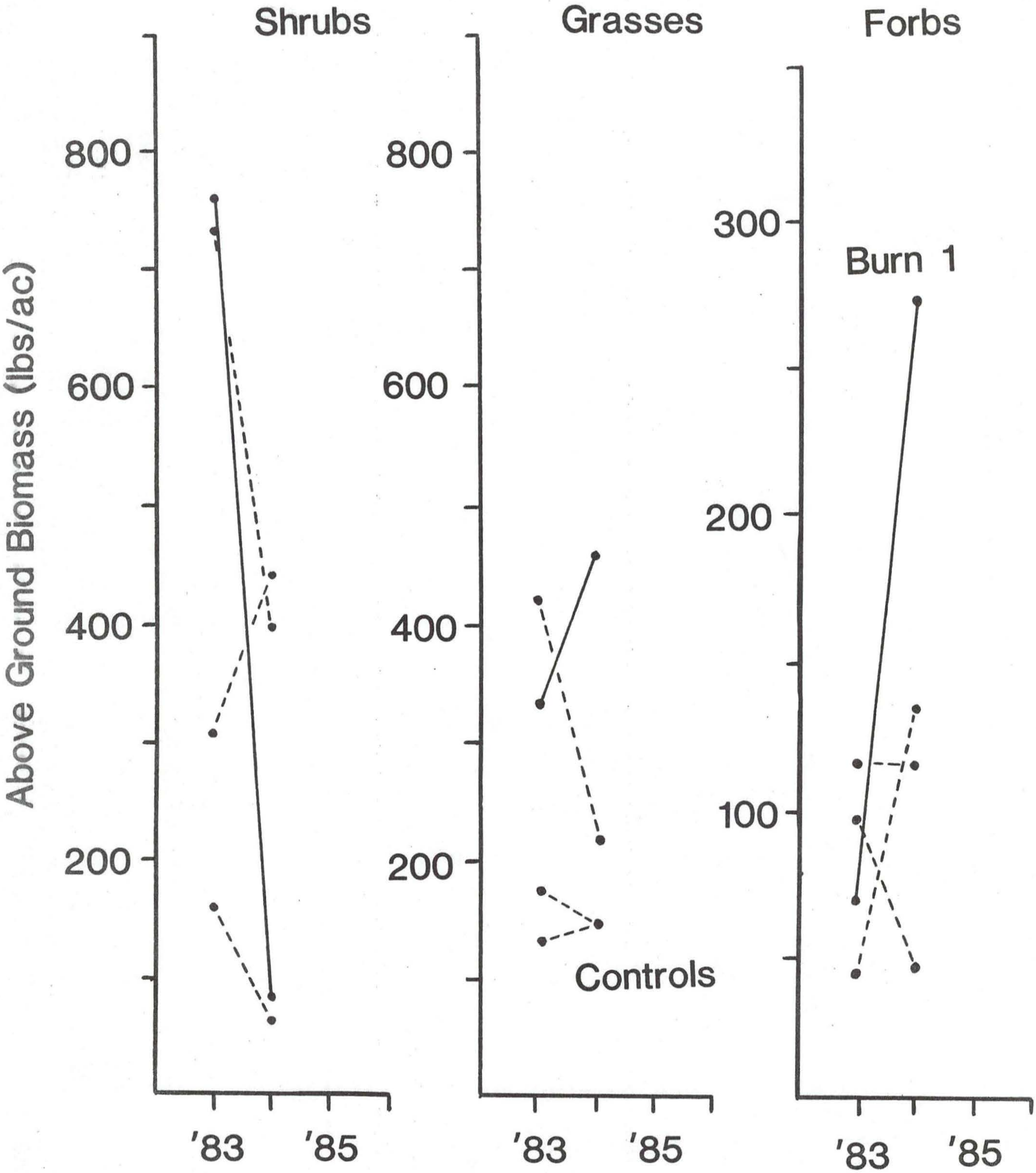
Appendix 7. Frequency measurements for Sandberg's bluegrass from Laidlaw Park, Shoshone District, Idaho BLM.



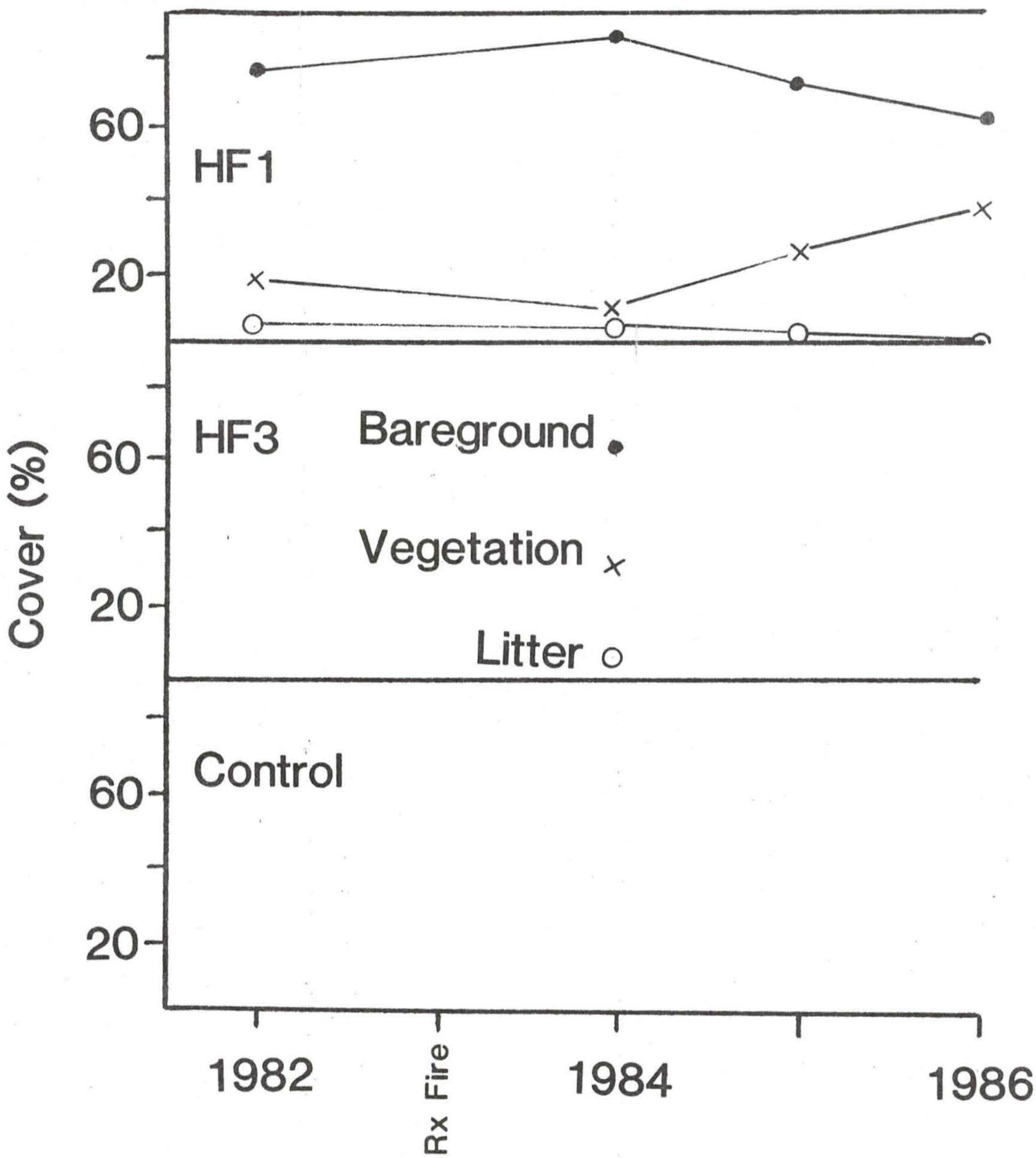
Appendix 8. Frequency and above ground biomass measurements for Hood's phlox from Laidlaw Park, Shoshone District, Idaho BLM.



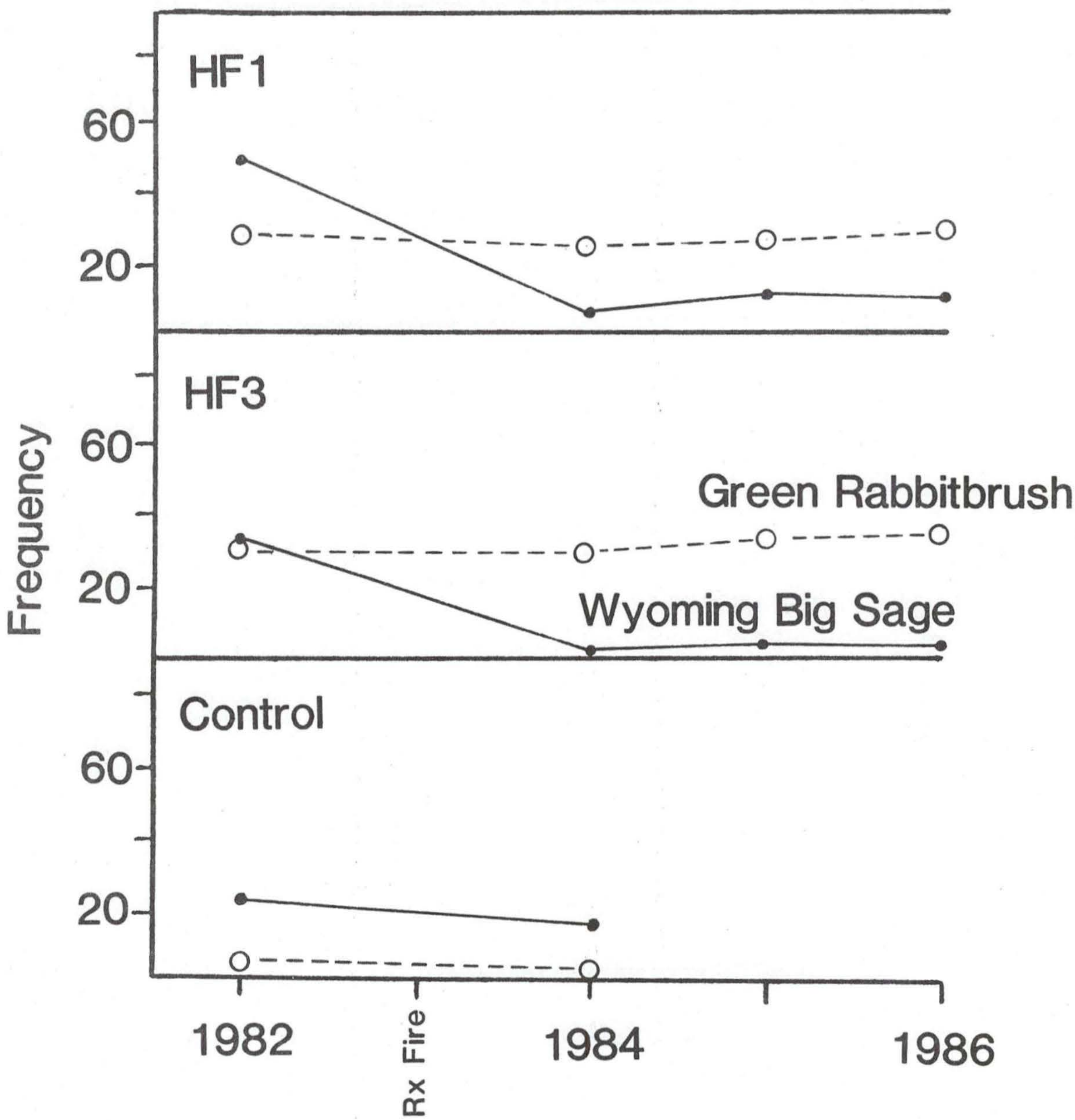
Appendix 9. Frequency and above ground biomass measurements for longleaf phlox from Laidlaw Park, Shoshone District, Idaho BLM.



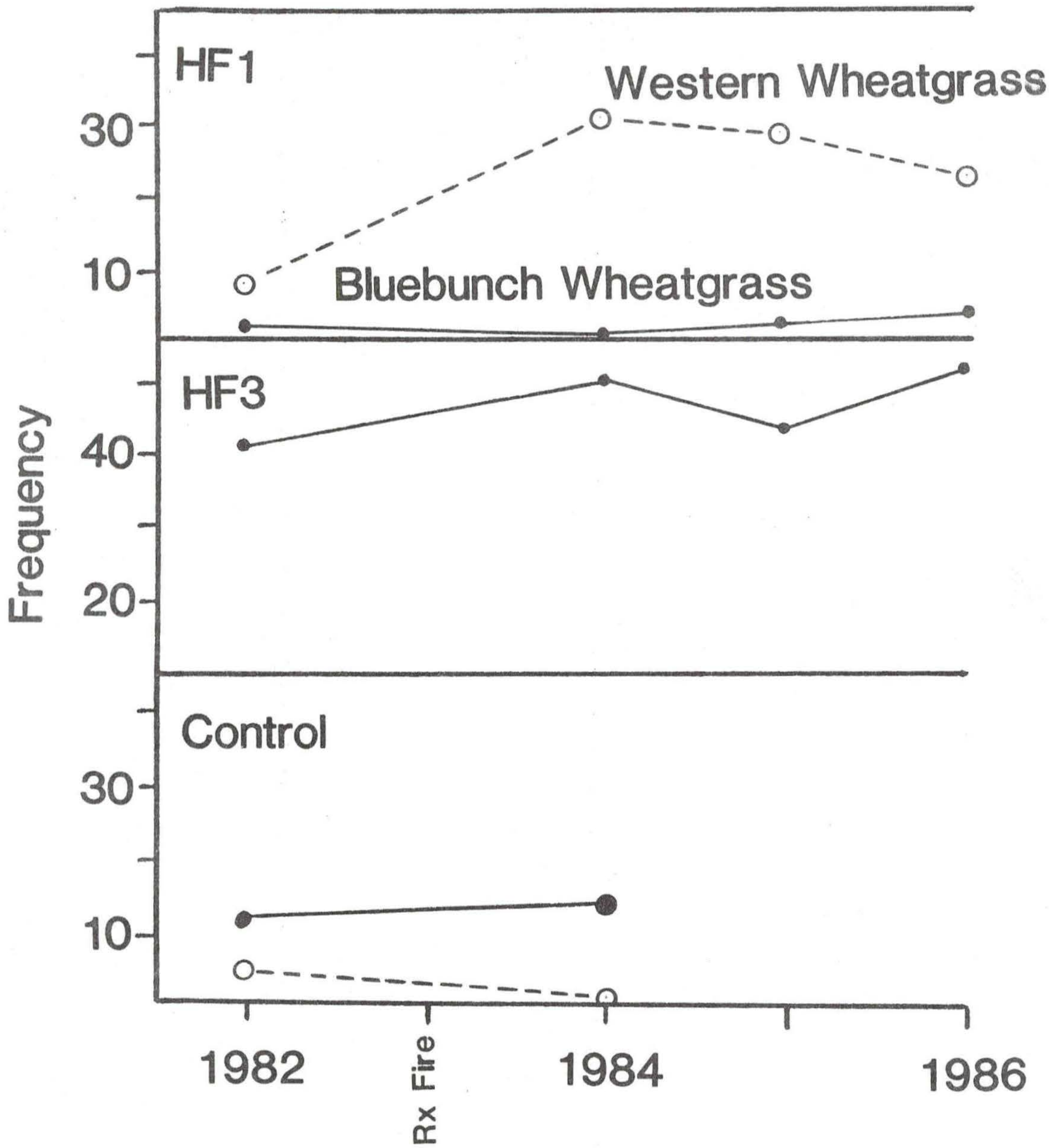
Appendix 10. Above ground biomass measurements for the shrub, grass and forb vegetation components from Laidlaw Park, Shoshone District, Idaho BLM.



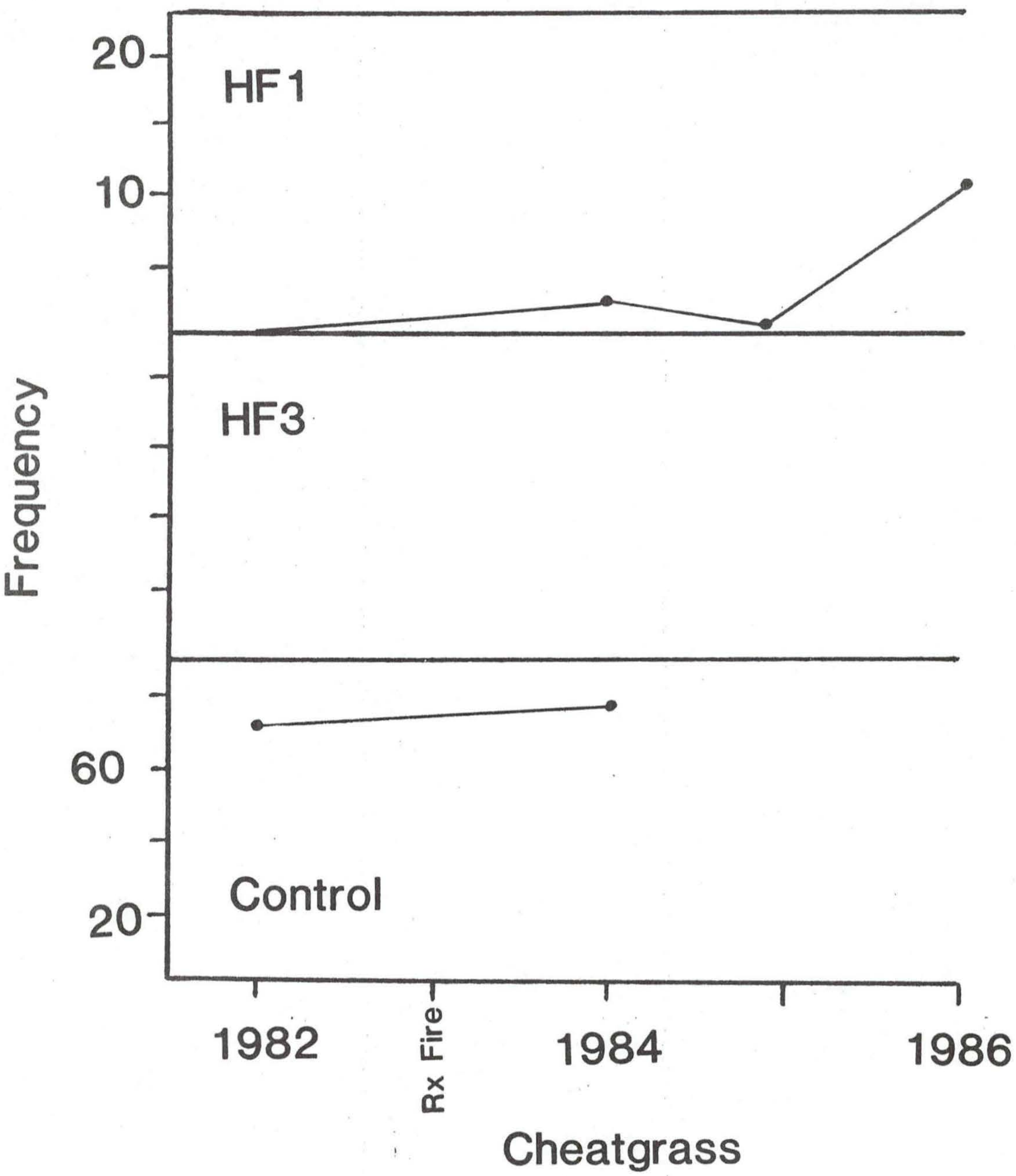
Appendix 11. Percent coverage of the bare ground, litter and vascular vegetation components from the Holborn Allotment, Elko District, Nevada BLM.



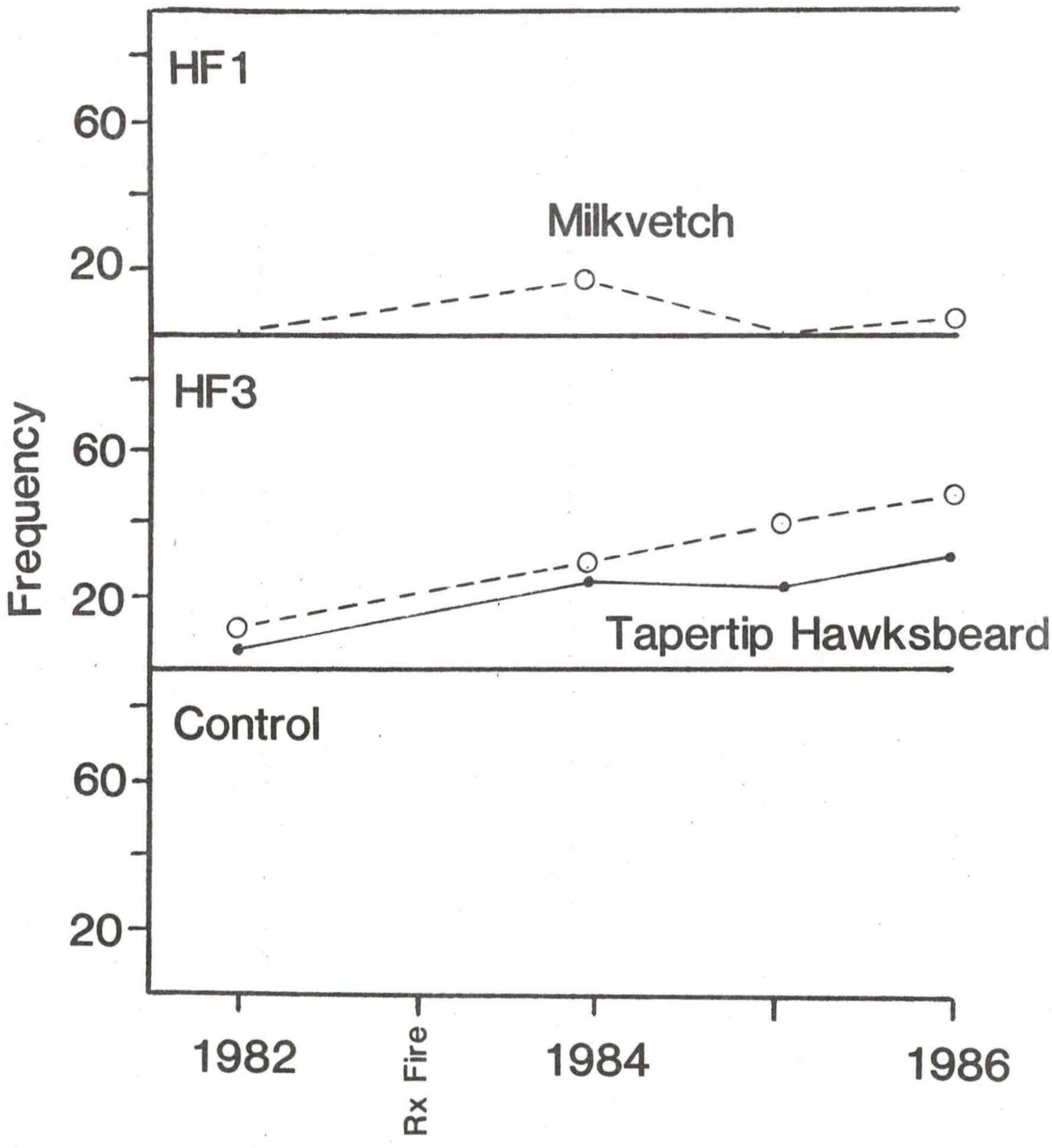
Appendix 12. Frequency measurements for Wyoming big sagebrush and green rabbitbrush from the Holborn Allotment, Elko District, Nevada BLM.



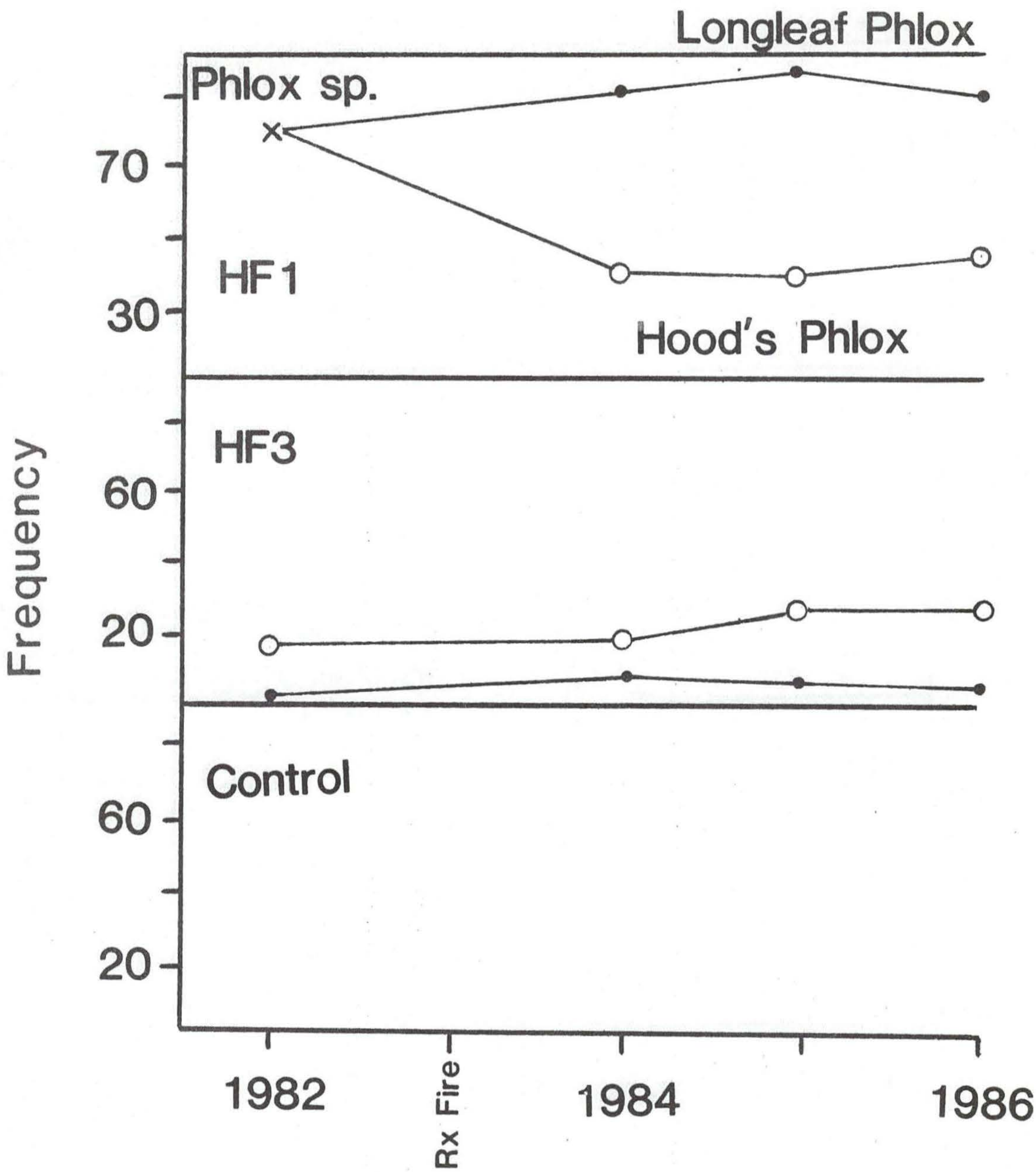
Appendix 13. Frequency measurements for bluebunch and western wheatgrasses from the Holborn Allotment, Elko District, Nevada BLM.



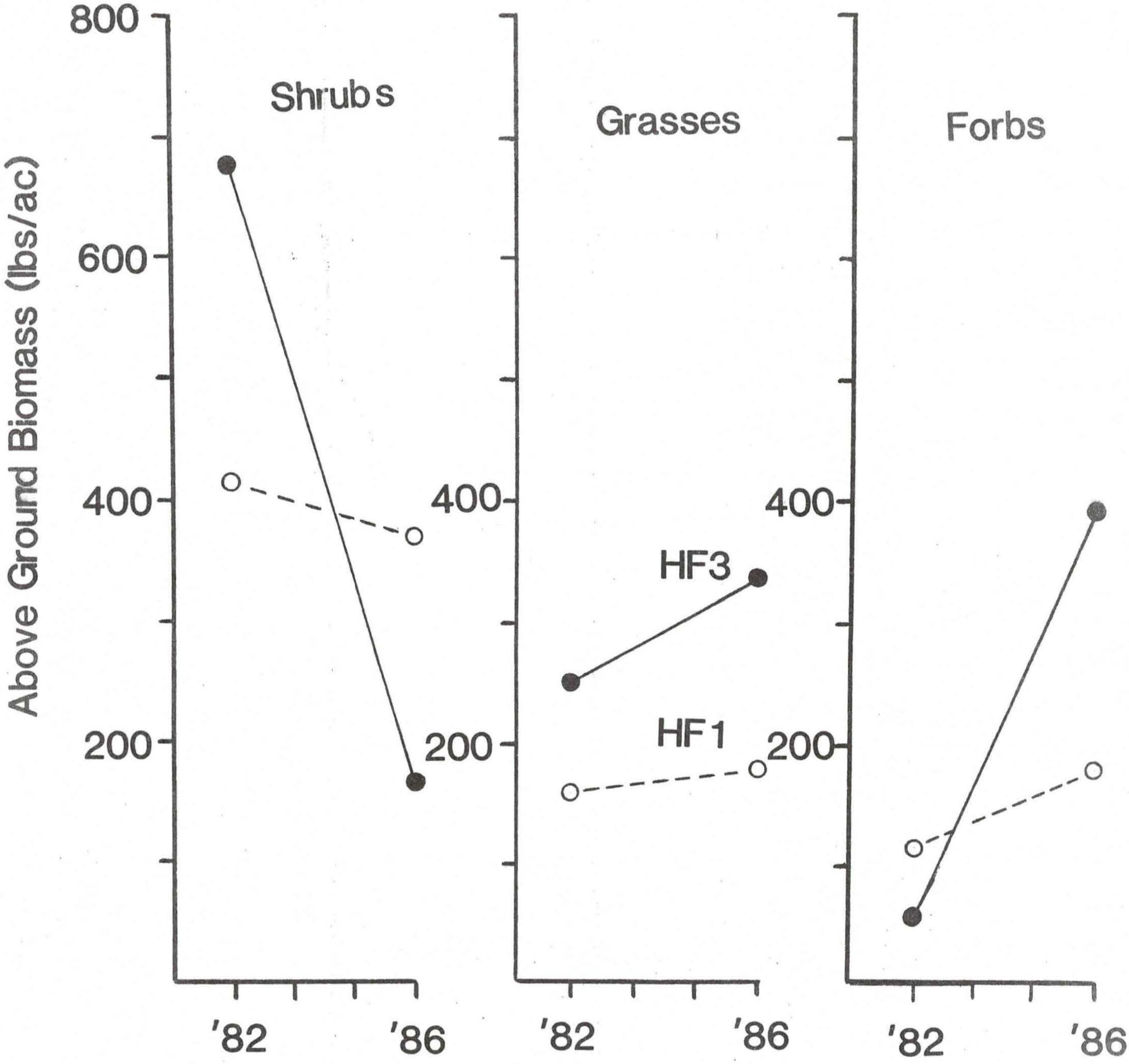
Appendix 14. Frequency measurements for cheatgrass from the Holborn Allotment, Elko District, Nevada BLM.



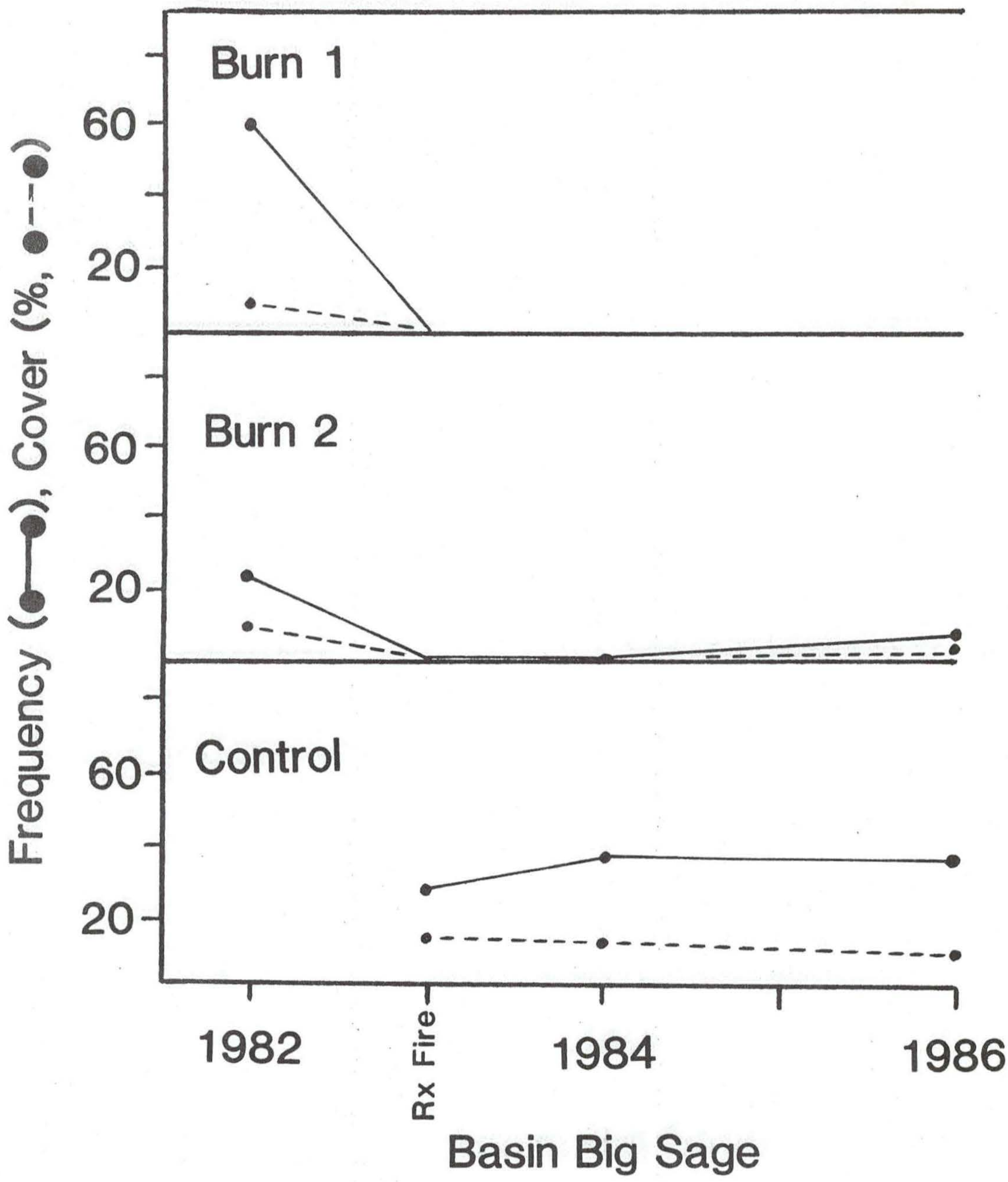
Appendix 15. Frequency measurements for milkvetch and tapertip hawksbeard from the Holborn Allotment, Elko District, Nevada BLM.



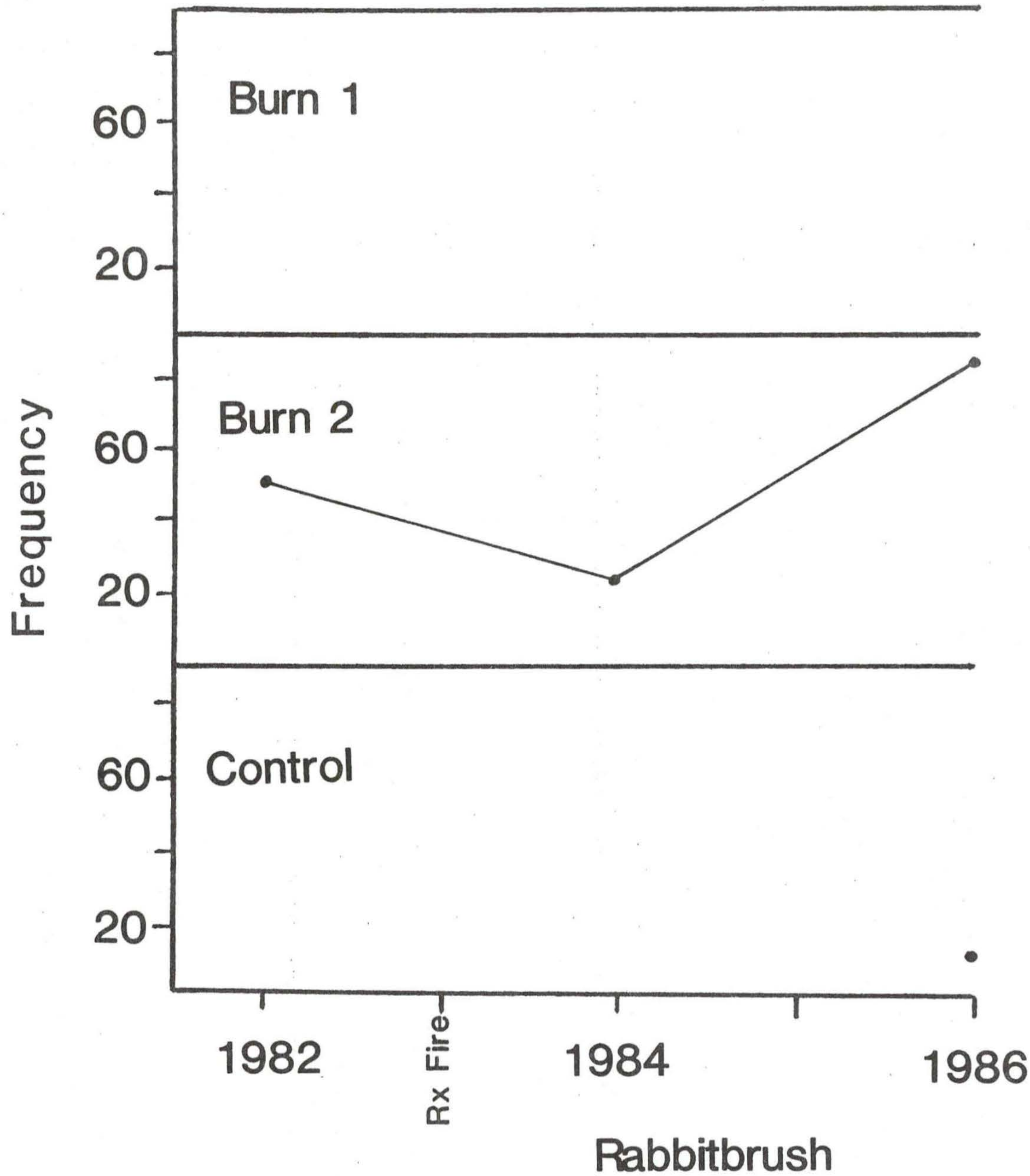
Appendix 16. Frequency measurements for Hood's phlox and longleaf phlox from the Holborn Allotment, Elko District, Nevada BLM. Note that the 1982 measurement from HF1 did not delineate between the two species.



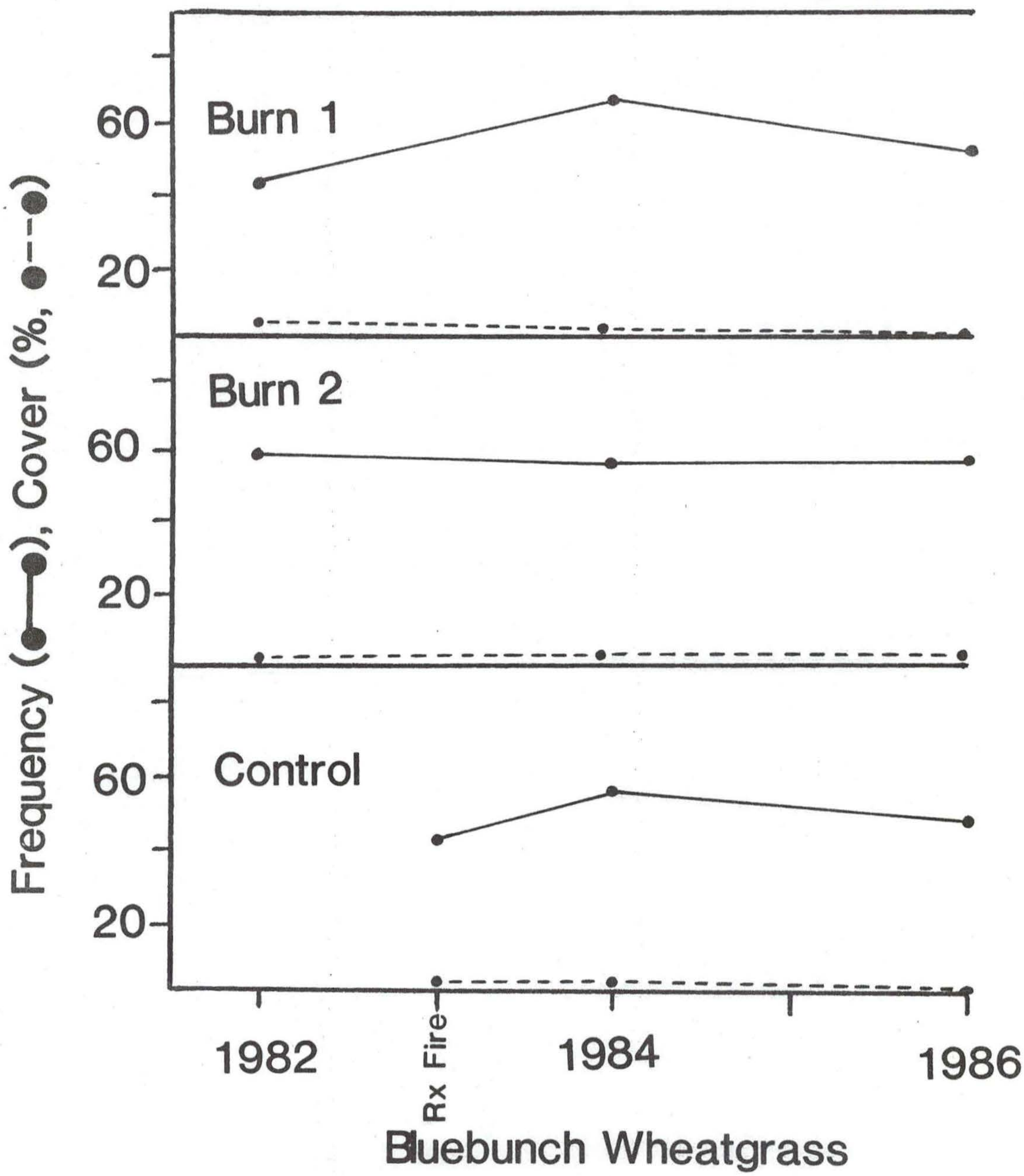
Appendix 17. Above ground biomass measurements for the shrub, grass and forb vegetation components from the Holborn Allotment, Elko District, Nevada BLM.



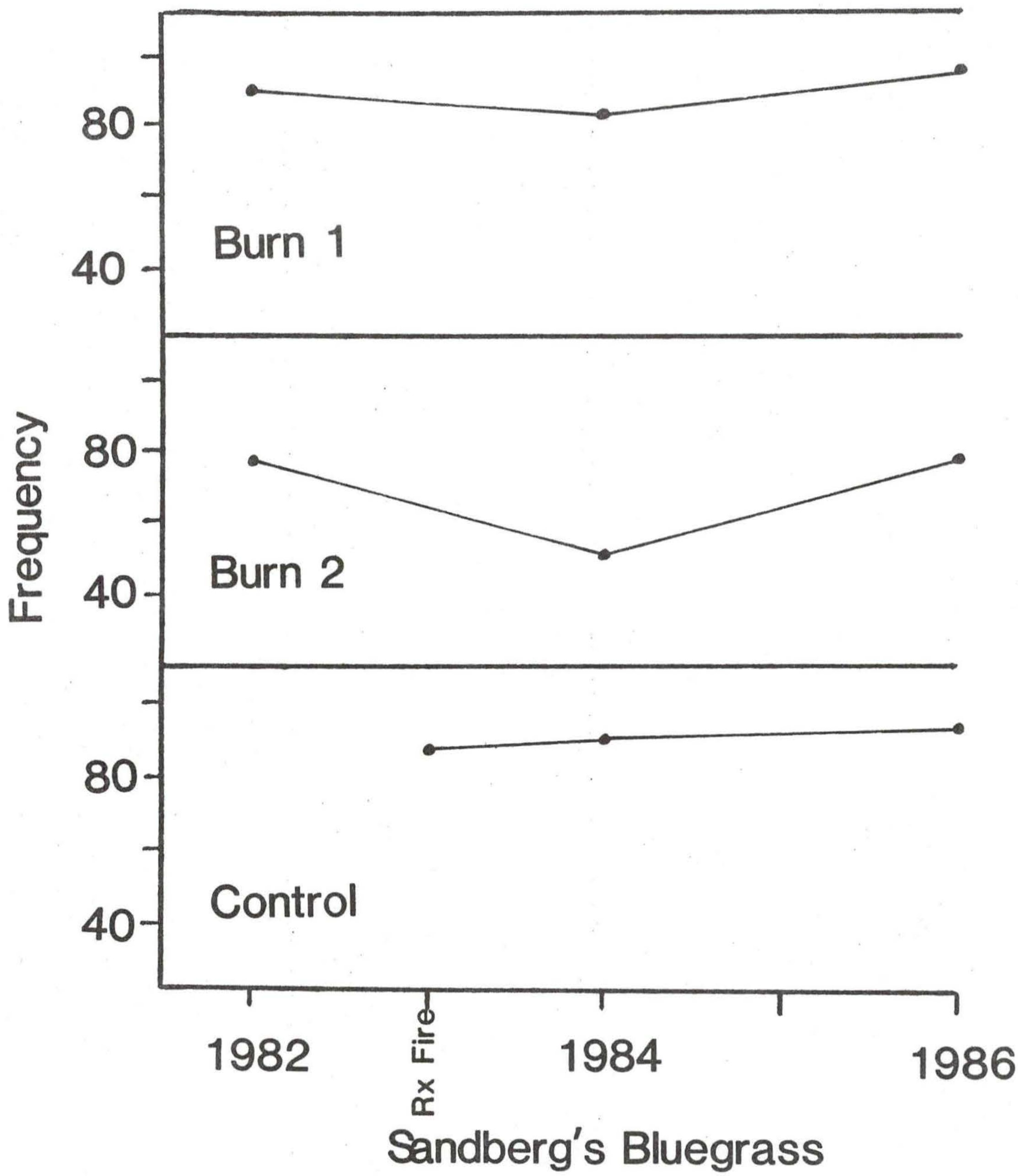
Appendix 18. Frequency and percent coverage measurements for basin big sagebrush from the Whitehorse Allotment, Vale District, Oregon BLM.



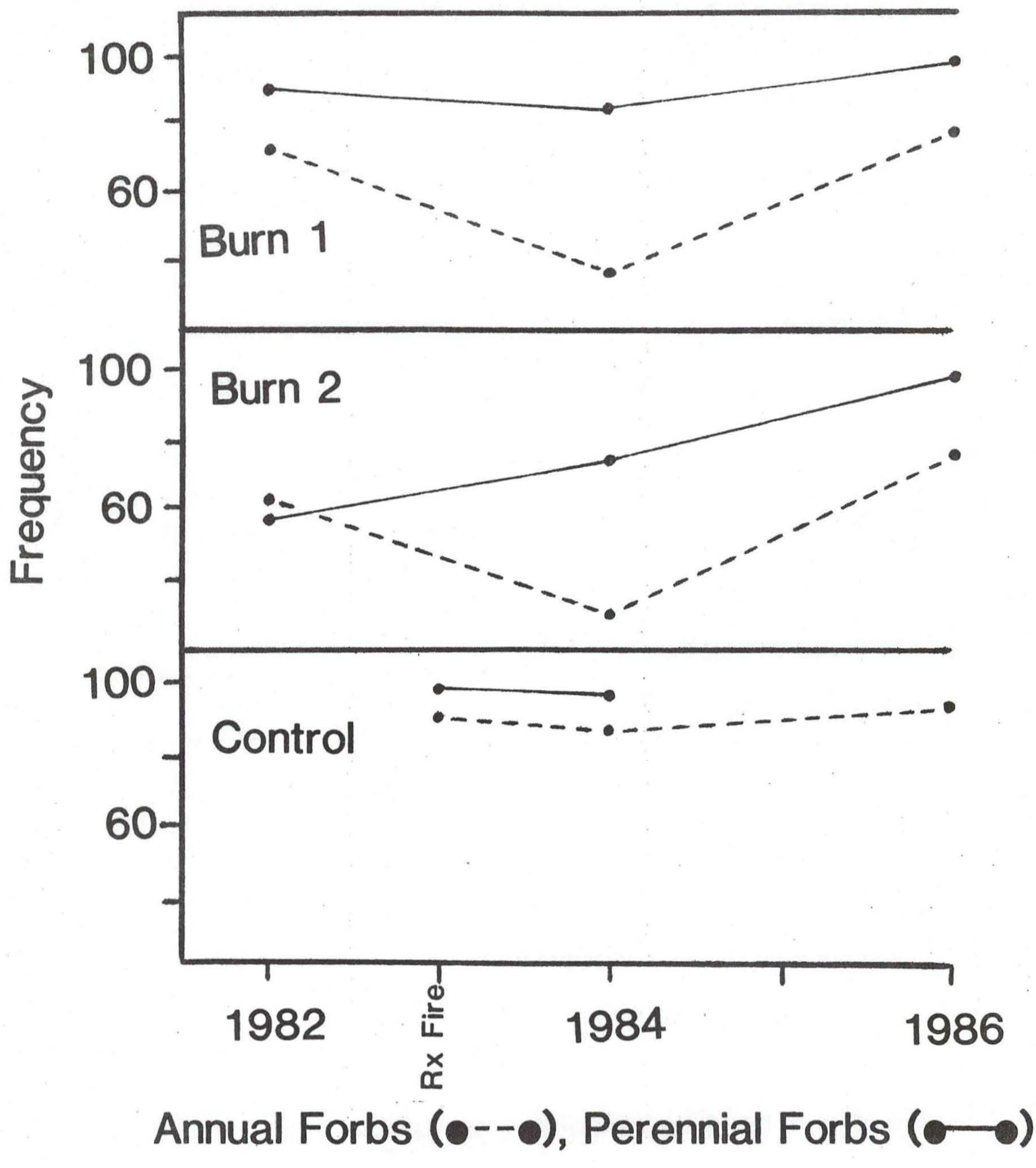
Appendix 19. Frequency measurements for rabbitbrush (Chrysothamnus viscidiflorus and C. nauseosus) from the Whitehorse Allotment, Vale District, Oregon BLM.



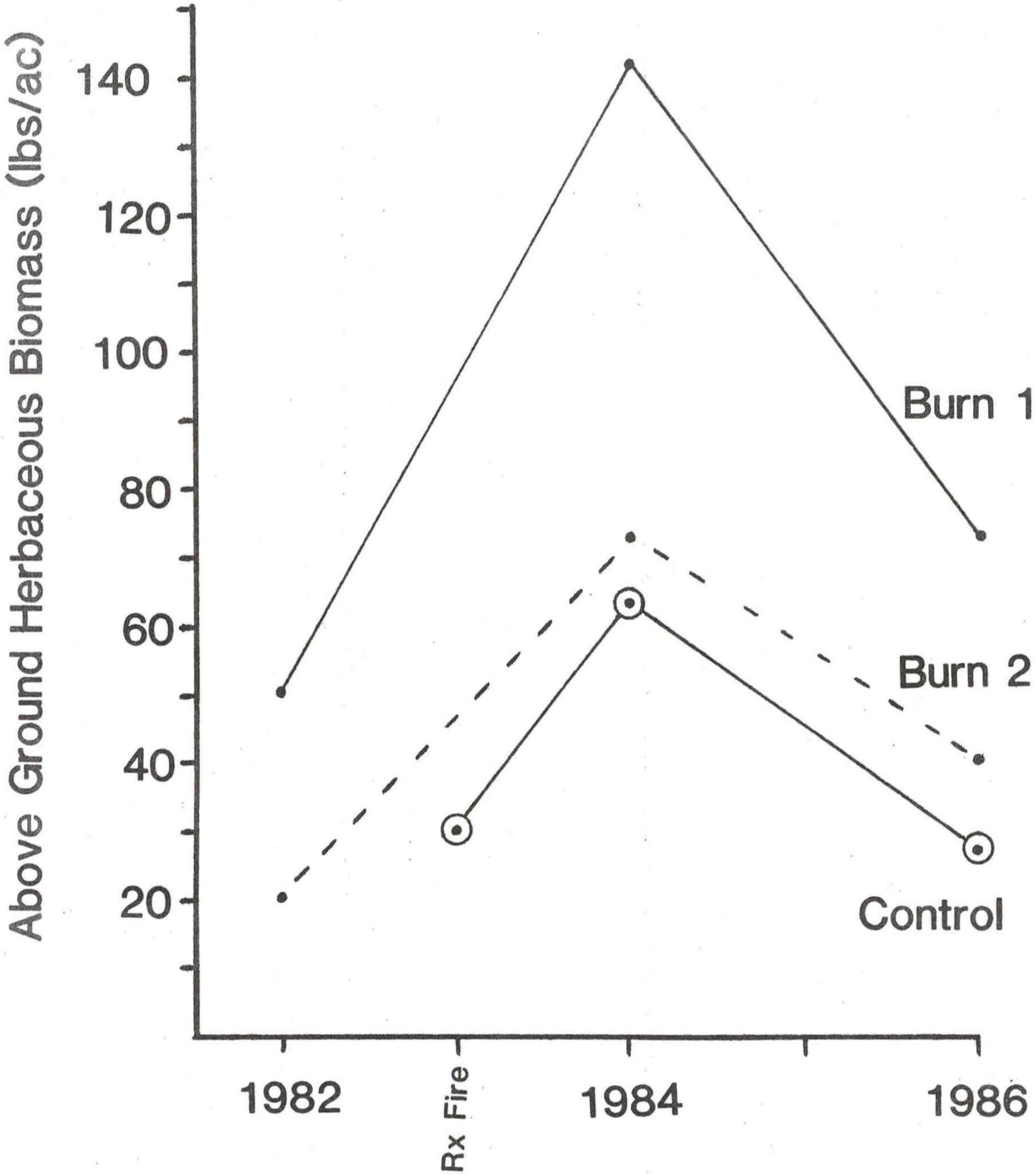
Appendix 20. Frequency and percent coverage measurements for bluebunch wheatgrass from the Whitehorse Allotment, Vale District, Oregon BLM.



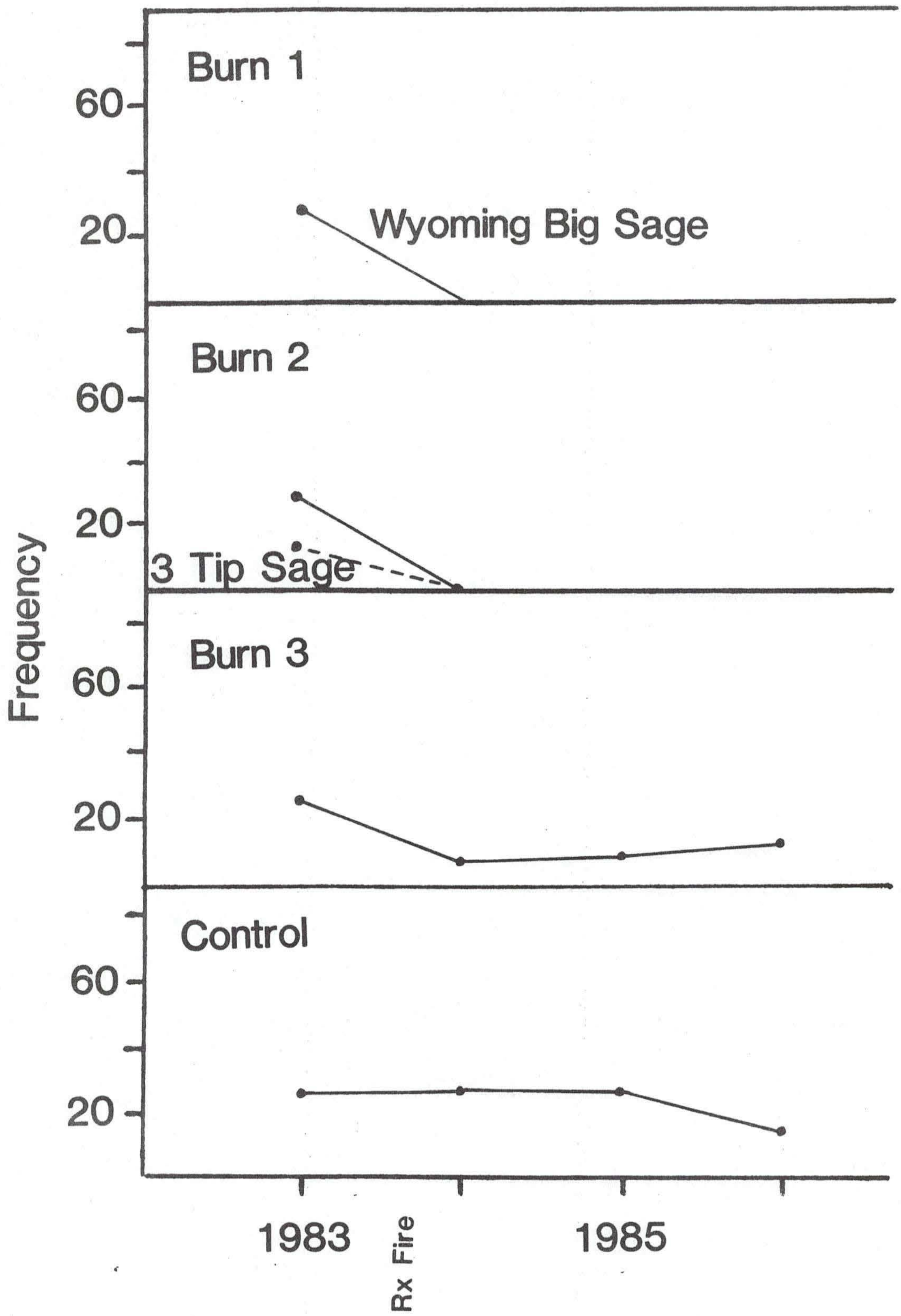
Appendix 21. Frequency measurements for Sandberg's bluegrass from the Whitehorse Allotment, Vale District, Oregon BLM.



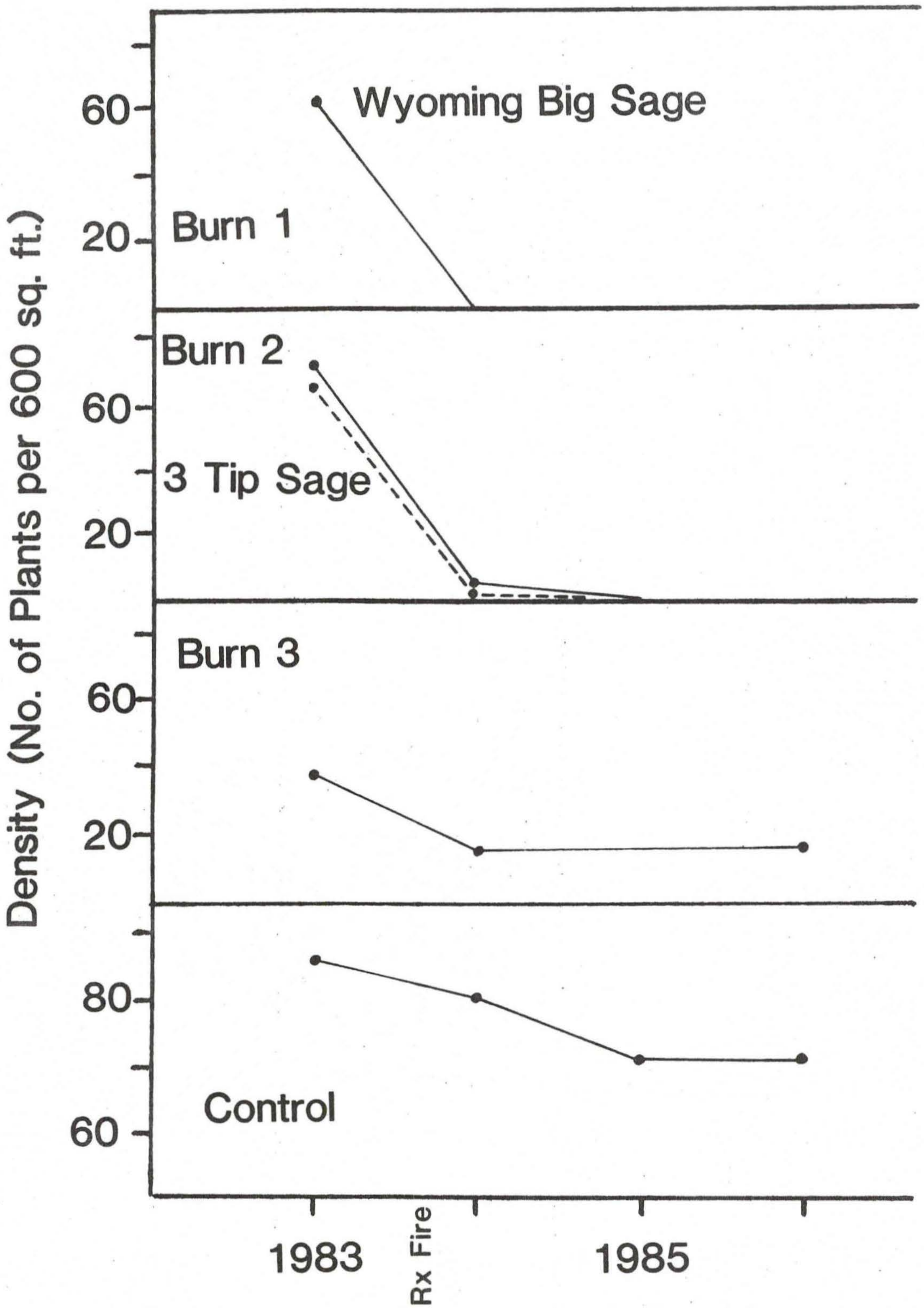
Appendix 22. Frequency measurements for the annual and perennial forb groups from the Whitehorse Allotment, Vale Dsitrict, Oregon BLM.



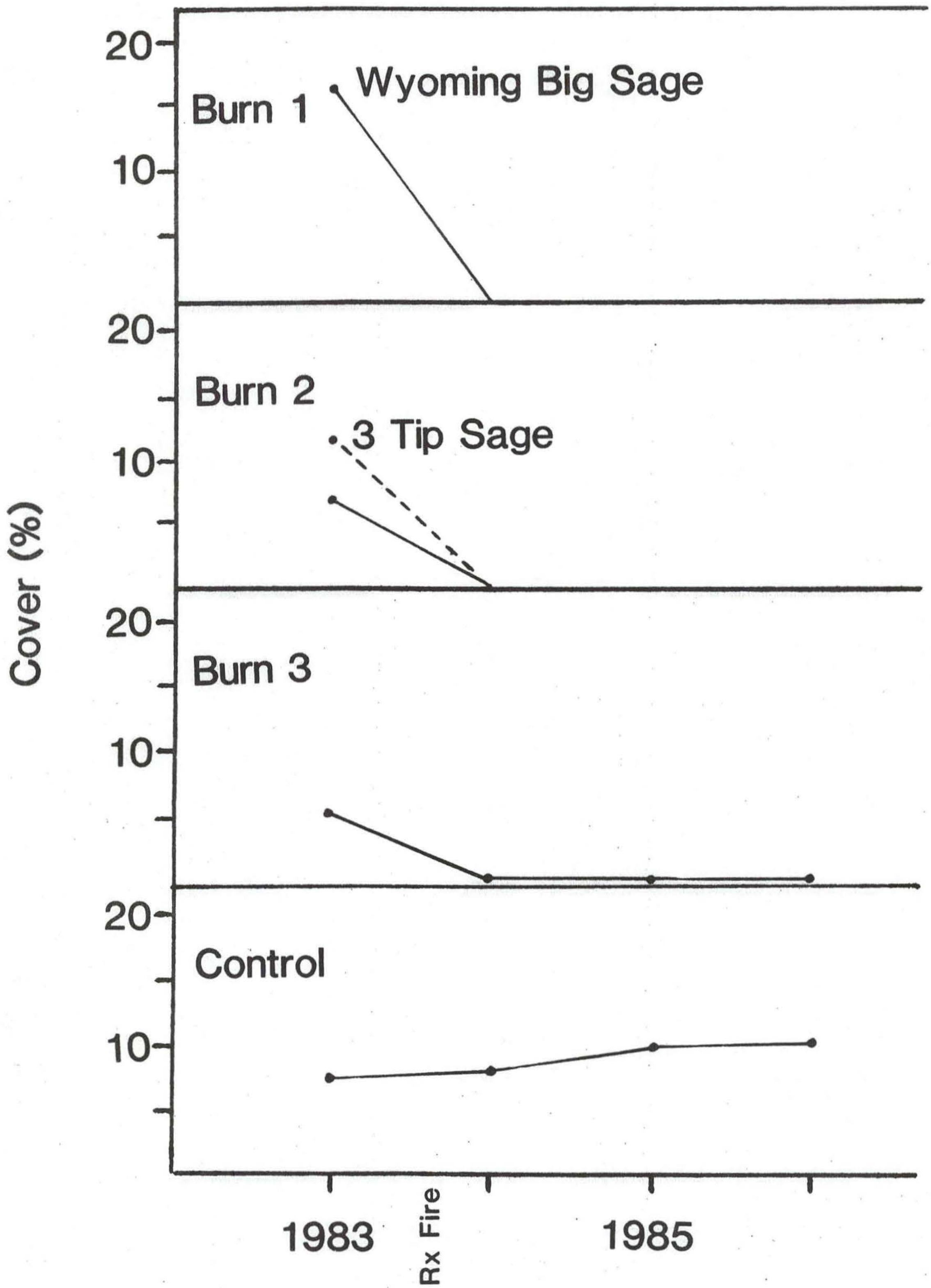
Appendix 23. Above ground biomass measurements for principal graminoid species from the Whitehorse Allotment, Vale Dsitrict, Oregon BLM.



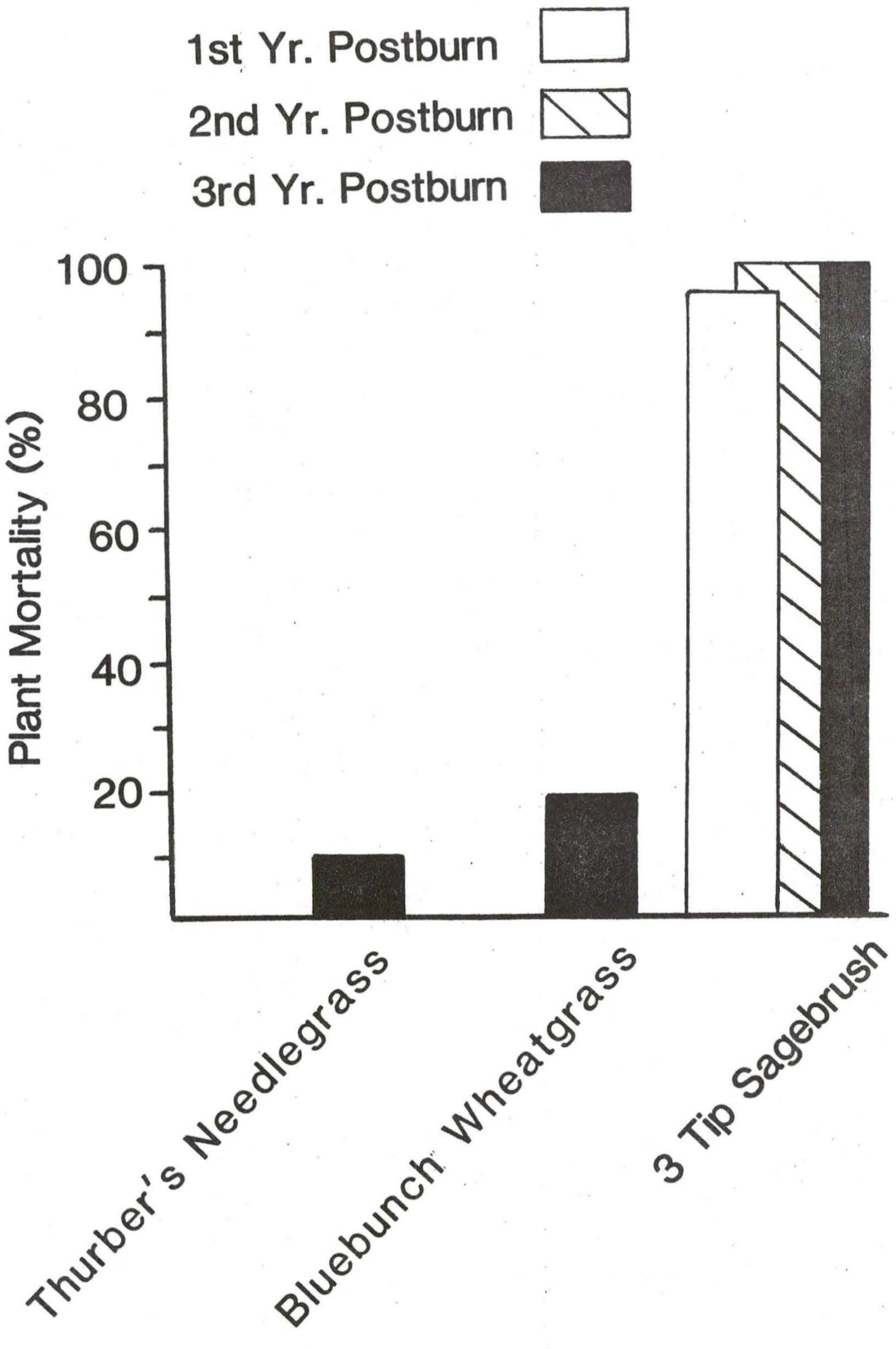
Appendix 24. Frequency measurements for Wyoming big sagebrush and Three-tip sagebrush from the Northridge Allotment, Vale District, Oregon BLM.



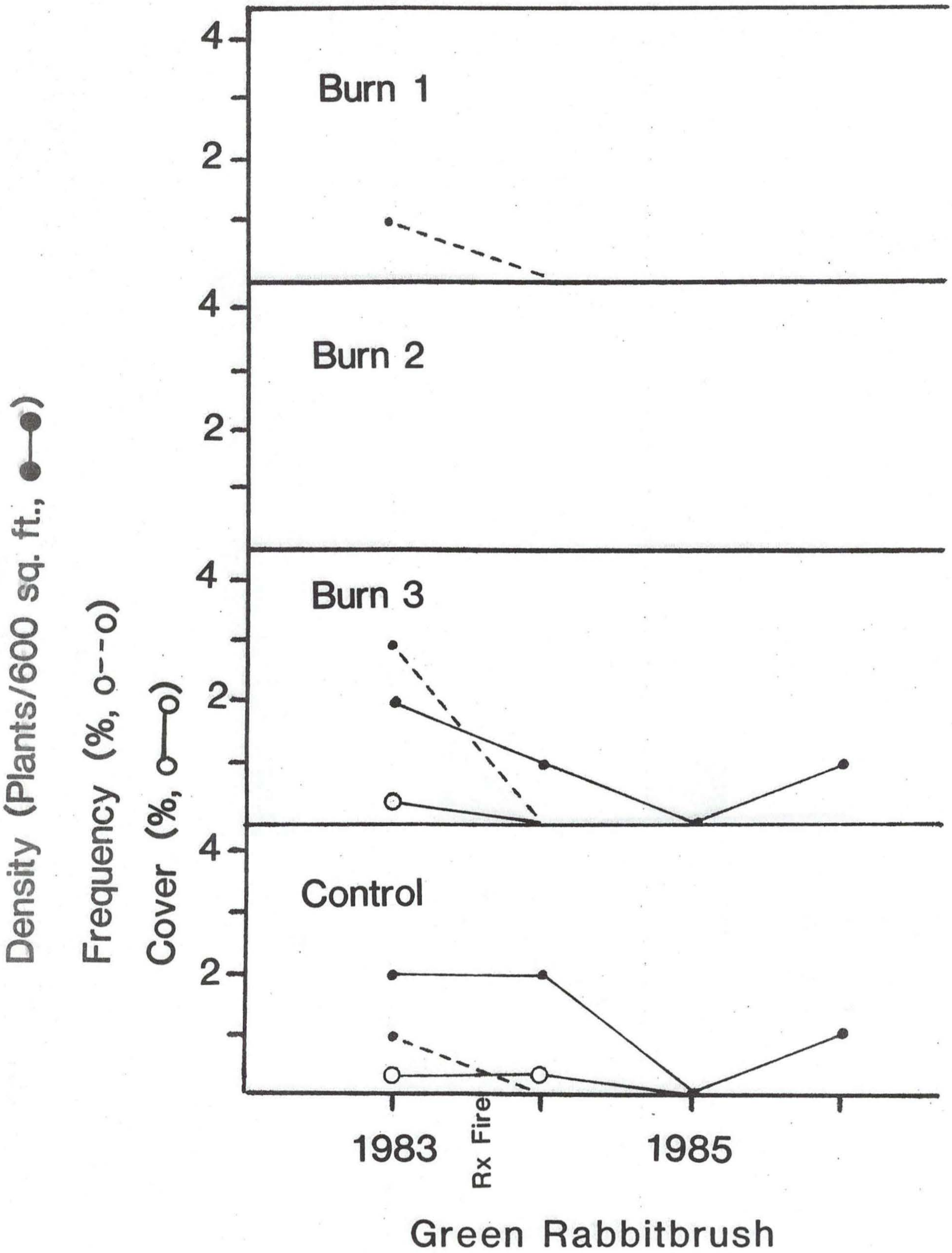
Appendix 25. Density measurements for Wyoming big sagebrush and three-tip sagebrush from the Northridge Allotment, Vale District, Oregon BLM.



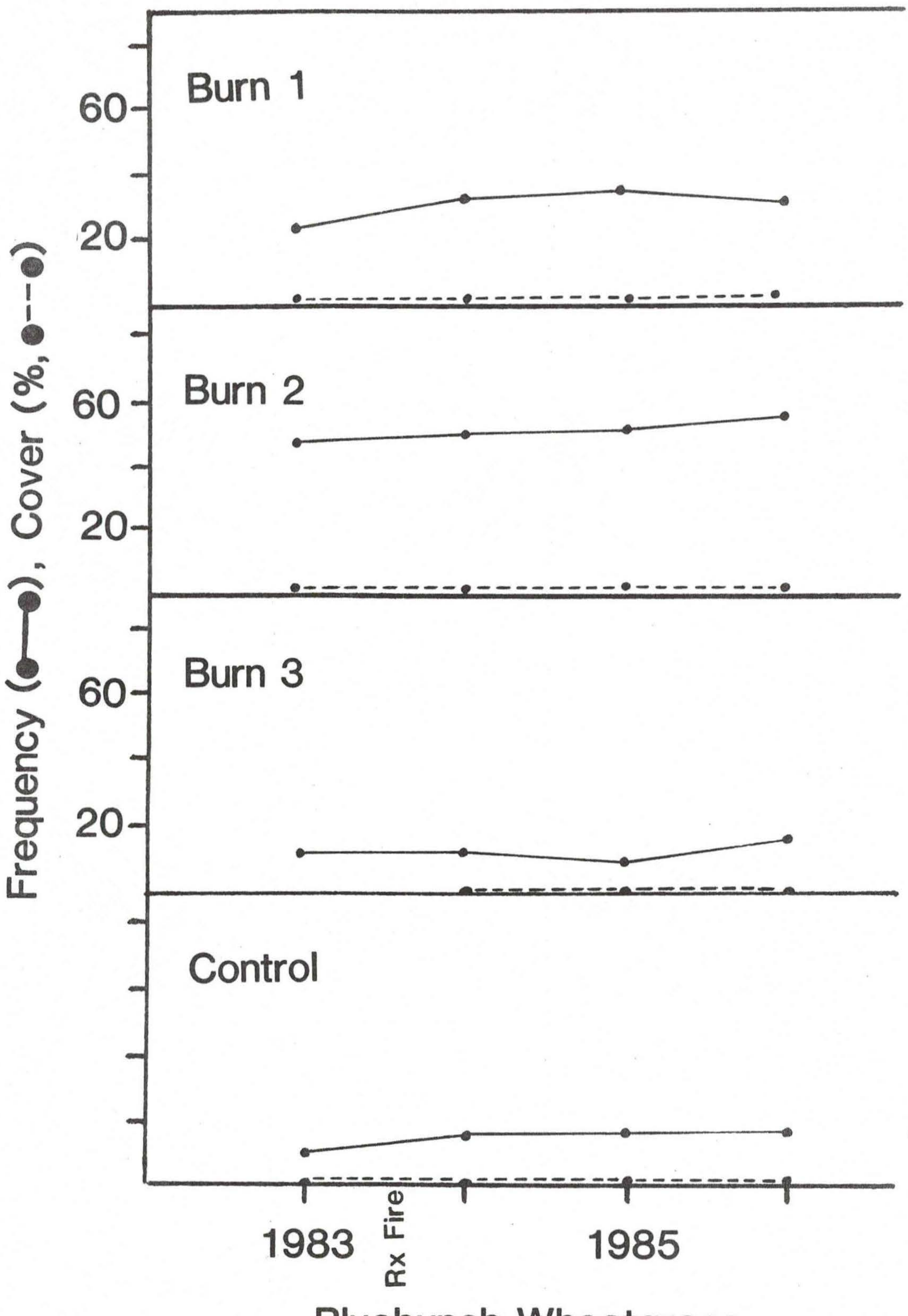
Appendix 26. Percent coverage for Wyoming big sagebrush and three-tip sagebrush from the Northridge Allotment, Vale District, Oregon BLM.



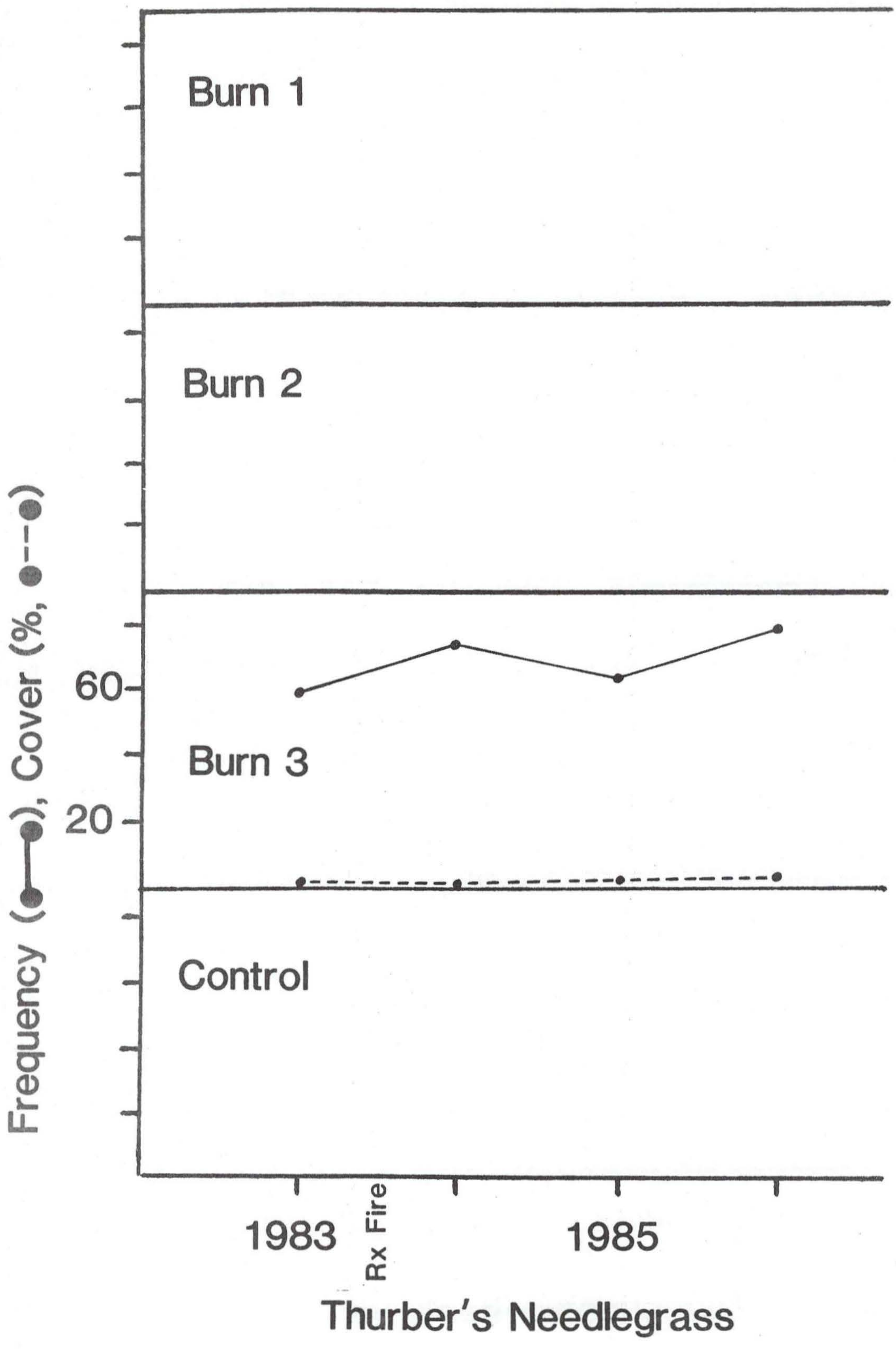
Appendix 27. Plant mortality / survival study from the Northridge Allotment prescribed fire treatment, Vale District, Oregon BLM.



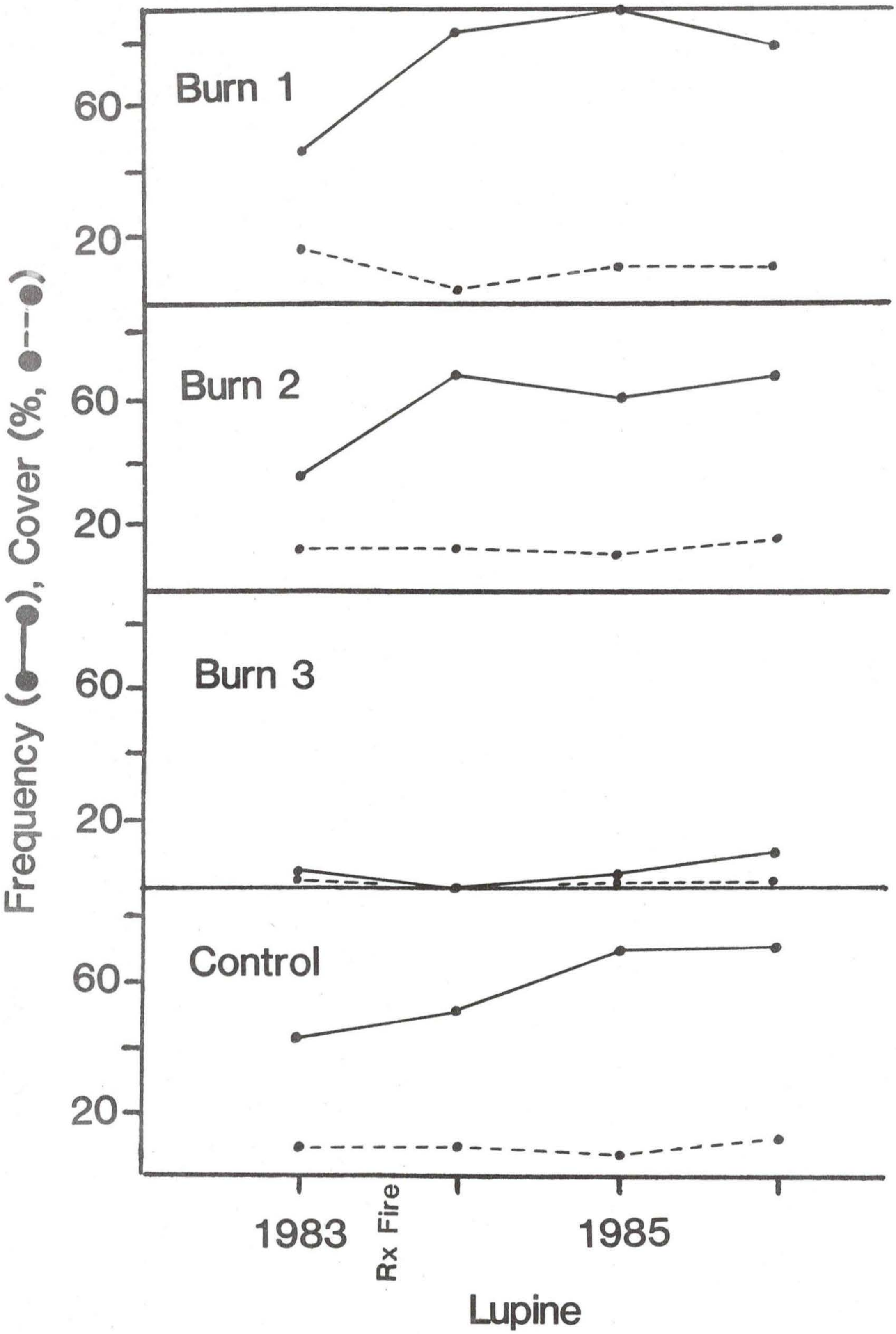
Appendix 28. Density, frequency and percent coverage measurements for green rabbitbrush from the Northridge Allotment, Vale District, Oregon BLM.



Appendix 29. Frequency and percent coverage measurements for bluebunch wheatgrass from the Northridge Allotment, Vale District, Oregon BLM.



Appendix 30. Frequency and percent coverage measurements for Thurber's needlegrass from the Northridge Allotment, Vale District, Oregon BLM.



Appendix 31. Frequency and percent coverage measurements for lupine from the Northridge Allotment, Vale District, Oregon BLM.